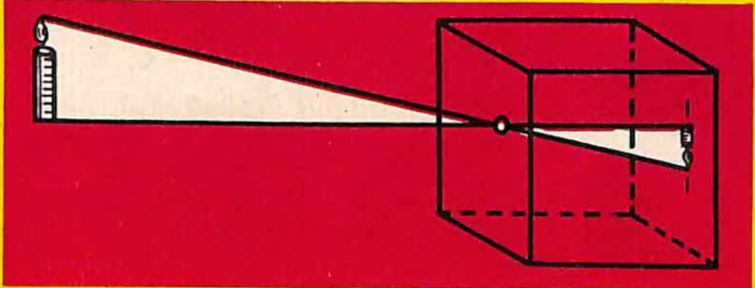
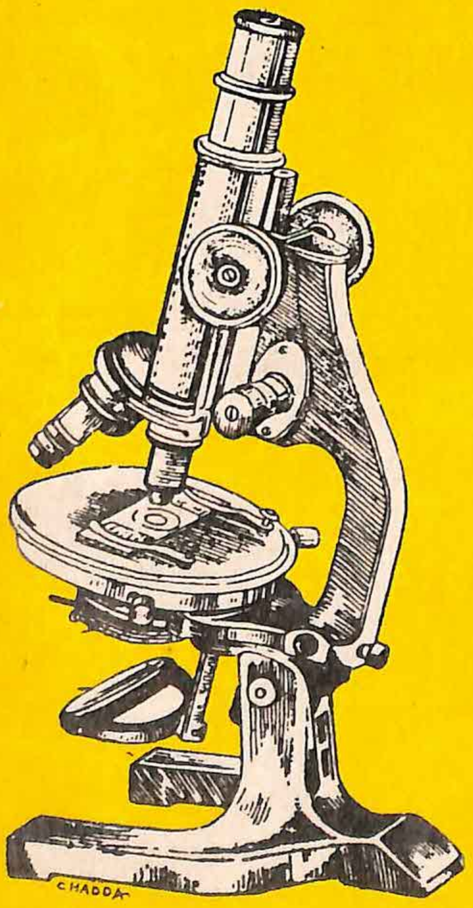
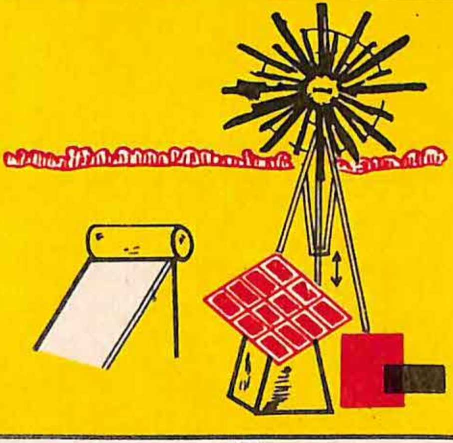
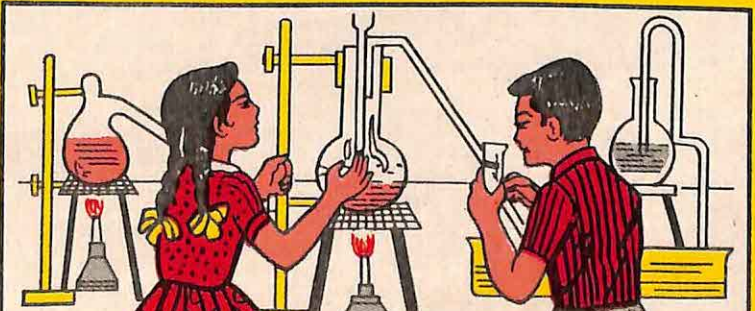
Modern Experimental SCIENCE

VOL I









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MODERN EXPERIMENTAL SCIENCE

VOL. I

(FOR CLASS IX)

2087

By

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PREFACE

This book has been written on the latest syllabus prescribed by the Central Board of Secondary Education, New Delhi for class IX on practicals in science under the new education policy.

The emphasis in learning of science has been shifted to experimentation, observation and investigation rather than on memorisation of facts. The book presents a new approach to the study of science in everyday life through experiments.

The efforts of the authors have been to simplify each experiment to the level of the students and to explain it with the help of quality diagrams. The diagrams are clear, neat and accurately drawn. The style of the book and the quality of the contents is such that it will create in the students an interest in learning science practically by experiments. It would lead them to better understanding of the subject. They will gain the necessary self-confidence in the subject and acquire a natural curiosity to do more experiments of this kind.

There is always scope for improvements. Such improvements depend on the suggestions of students, parents and teachers of the particular subject. Their comments are most welcome.

We are thankful to the publishers M/S Pitambar Publishing Company for bringing out this book in the shortest possible time.

AUTHORS

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UNIT 1

MATTER, NATURE AND BEHAVIOUR

Introduction

A. LABORATORY INSTRUCTIONS

Every student should have a practical note-book. While entering the observations in the practical note-book, the following points should always be remembered. Some laboratory instructions should also be followed.

1. Enter the laboratory with your practical note-book.

2. Keep your apparatus and table neat and clean. Cleanliness is essential for systematic and efficient work.

3. Never throw any solid matter or pieces of paper into the sink otherwise the pipe will be choked.

4. Never take away the reagent bottle placed in the common shelf to your seat.

5. Avoid talking, whispering, or moving about in the laboratory.

6. No substance should be tasted without permission.

7. Always enter your observations directly into the note-book.

8. Put the date on which the work was carried out. Don't forget to write the serial number of the experiments.

9. Never consult your neighbour otherwise you may be misled.

10. Record the observations and calculations on the left hand side of the note-book.

11. Try to write chemical equations where and when necessary.

12. Don't remove the pages from the note-book.

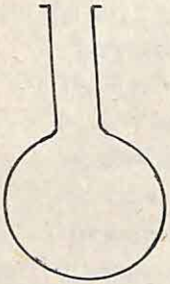
13. When the practical is over, get your note-book signed by the teacher.

B. LIST OF THE APPARATUS

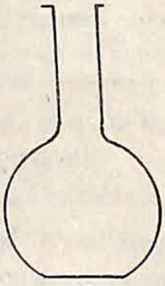
Experiment 1. *To become acquainted with common laboratory apparatus.*

Various types of the apparatus commonly used in the laboratory are given below :

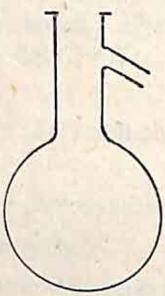
(1) Round-Bottomed flask. (2) Flat-Bottomed flask. (3) Distillation flask. (4) Conical flask. (5) Woulf's bottle. (6) Trough. (7) Retort. (8) Thistle funnel. (9) Separating funnel. (10) Funnel. (11) Beaker. (12) Beehive shelf. (13) Pestle Mortar. (14) China dish. (15) Crucible. (16) Water bath. (17) Bell jar. (18) Funnel Stand. (19) Iron stand. (20) Tripod stand. (21) Measuring flask. (22) Sand bath. (23) Spirit lamp (24) Bunsen burner. (25) Clay pipe triangle. (26) Pipette. (27) Wire gauze. (28) Burette. (29) Cylinder. (30) Test tube. (31) Deflagrating spoon (32) Triangular file. (33) Round file. (34) Tube. (35) Test tube stand. (36) Test tube holder. (37) Glass rod. (38) Chemical balance.



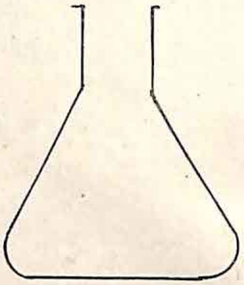
R. B. FLASK



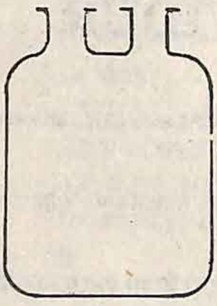
FLAT BOTTOMED FLASK



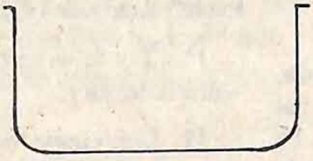
DISTILLATION FLASK



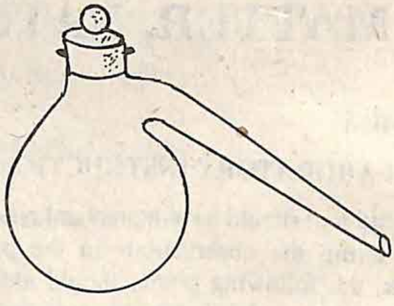
CONICAL FLASK



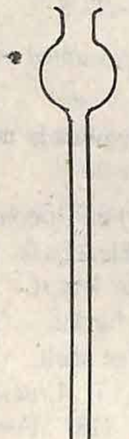
WOULF'S BOTTLE



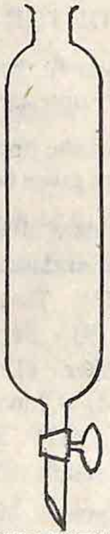
TROUGH



RETORT



THISTLE FUNNEL



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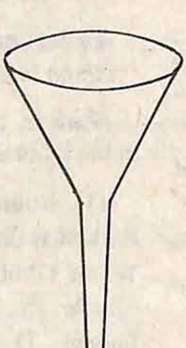

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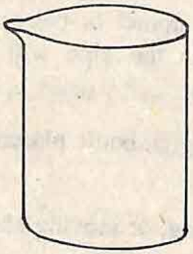

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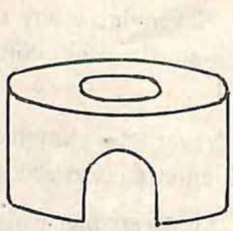

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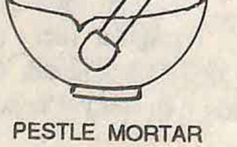

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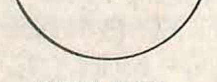

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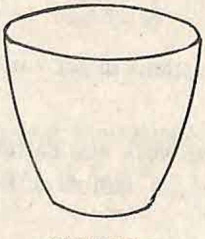

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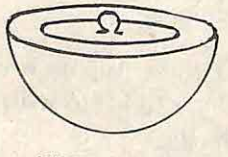
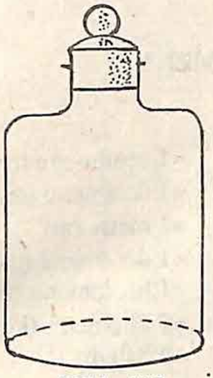


WATER-BATH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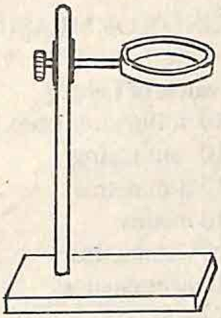
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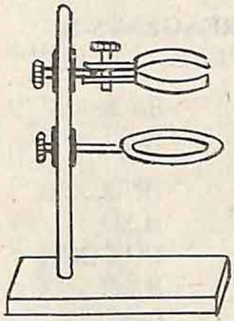
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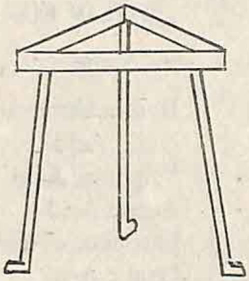
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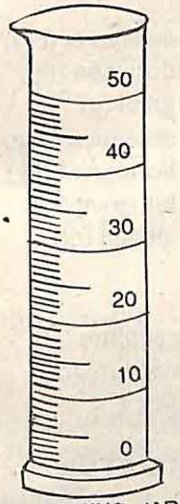
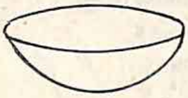


MEASURING JAR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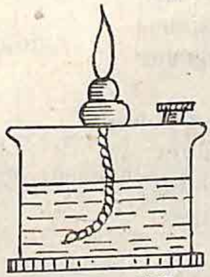
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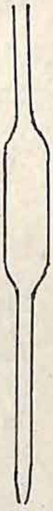
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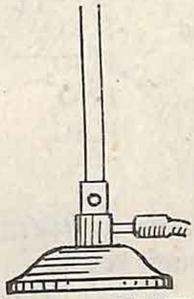
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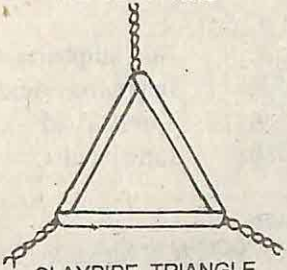
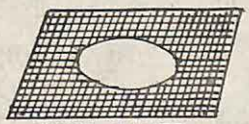

CLAYPIPE TRIANGLE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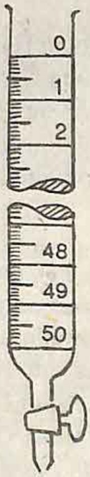
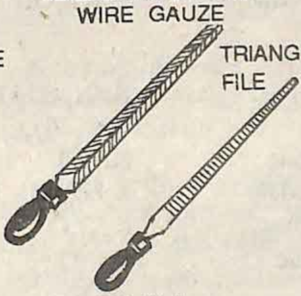


BURETTE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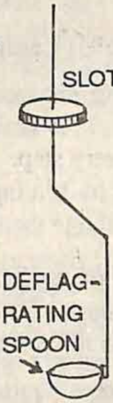
ROUND FILE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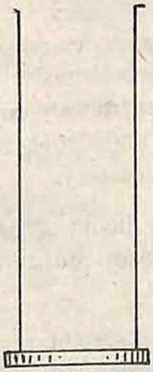
DEFLAGRATING SPOON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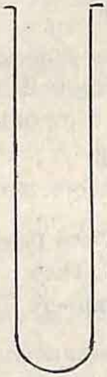
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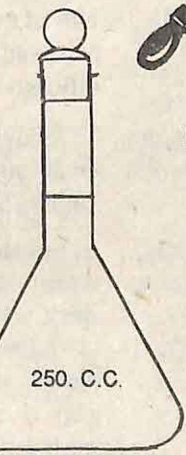

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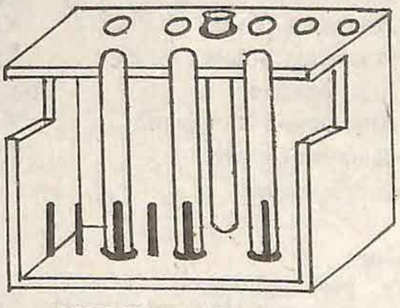
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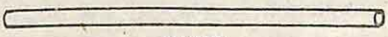
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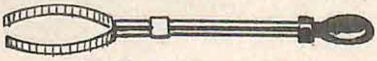
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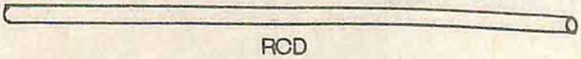

ROD

C. LIST OF COMMON REAGENTS & THEIR FORMULAE

Acids	*Name*	*Formulae*
1.	Hydrochloric Acid	HCl
2.	Nitric Acid	HNO_3
3.	Sulphuric Acid	H_2SO_4
4.	Acetic Acid	CH_3COOH
5.	Phosphoric Acid	H_3PO_4
6.	Oxalic Acid	$\begin{matrix}COOH\\ \vert \\ COOH\end{matrix} .2H_2O$
7.	Thio Sulphuric Acid	$H_2S_2O_3$
8.	Sulphurous Acid	H_2SO_3
9.	Nitrous Acid	HNO_2
10.	Boric Acid	H_3BO_3

Bases

1. Sodium Hydroxide (Caustic Soda)	$NaOH$
2. Potassium Hydroxide (Caustic Potash)	KOH
3. Calcium Hydroxide (Lime Water)	$Ca(OH)_2$
4. Sodium Carbonate (Washing Soda)	$Na_2CO_3.10H_2O$
5. Potassium Carbonate	K_2CO_3
6. Ammonium Hydroxide	NH_4OH

Reagents

1. Barium Chloride	$BaCl_2.2H_2O$
2. Ferrous Sulphate	$FeSO_4.7H_2O$
3. Ammonium Chloride	NH_4Cl
4. Potassium Ferocyanide	$K_4Fe(CN)_6$
5. Potassium Dichromate	$K_2Cr_2O_7$
6. Potassium Chromate	K_2CrO_4
7. Ferric Chloride	$FeCl_3$
8. Silver Nitrate	$AgNO_3$
9. Potassium Iodide	KI
10. Potassium Sulphocyanide	$KCNS$
11. Lead Acetate	$Pb(CH_3COO)_2$
12. Ammonium Molybdate	$(NH_4)_2MoO_4$
13. Stannous Chloride	$SnCl_2$
14. Cobalt Nitrate	$Co(NO_3)_2$

Indicators

(1) Phenolphthalein
(2) Litmus Solution
(3) Methyl Orange

D. UNITS OF MEASUREMENT

Measures of Length

10 millimetres (mm.) =1 centimetre (cm)
10 centimetres =1 decimetre (dm)
10 decimetres =1 metre (m)
10 metres =1 decametre (dam)
10 decametres =1 hectometre (hm)
10 hectometres =1 kilometre (km)
1 inch =2.54 cm

Measures of Weight

10 milligrams (mg) =1 centigram (cg)
10 centigrams =1 decigram (dg)
10 decigrams =1 gram (g)
10 grams =1 decagram (dag)
10 decagrams =1 hectogram (hg)
10 hectograms =1 kilogram (kg)
100 kilograms =1 quintal (ql)

Measures of Volume

10 millilitres =1 centilitre (cl)
10 centilitres =1 decilitre (dl)
10 decilitres =1 litre (l)

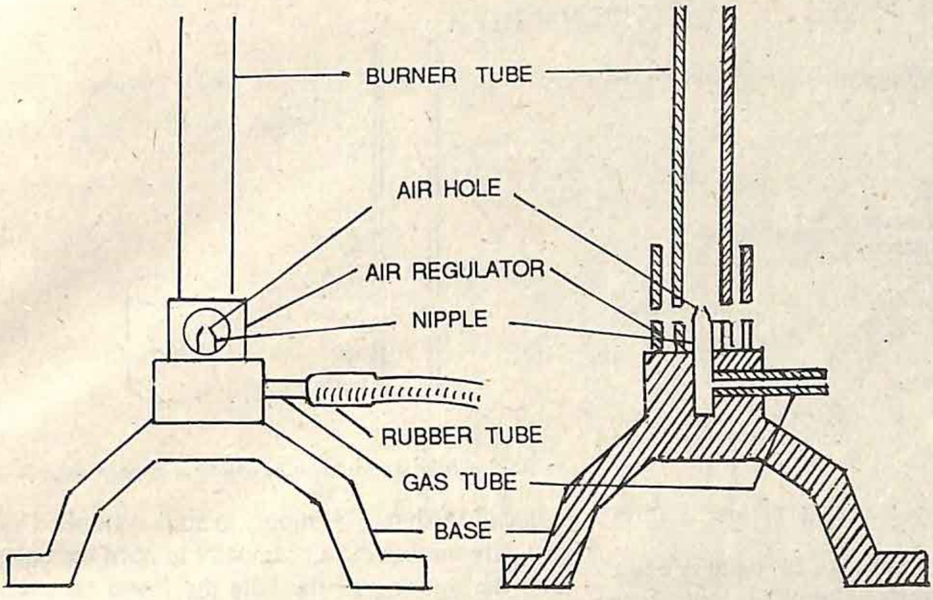
E. HANDLING OF LABORATORY EQUIPMENT

(a) Spirit Lamp

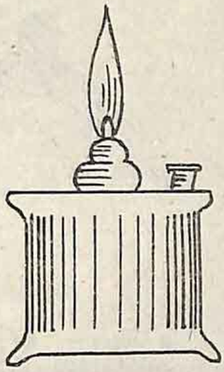
Heating is an indispensable operation in Chemistry. It is required in chemical analysis at almost every step. Most of the preparations too are achieved by heating. A thorough knowledge of an efficient flame therefore, is very necessary.

Study of appliances producing flame carries a great importance. These appliances are of two kinds—lamps and burners.

In lamps, inflammable liquid produces the flame. Most common liquid used is methylated spirit. The lamp in which spirit is used is called spirit lamp. In most of the school laboratories or at places where production of gas (oil gas or petrol gas) is not economically or otherwise possible, spirit lamps are used. They are made of glass or brass. The use of latter type is safer.



COMPLETE BURNER SECTIONAL DIAGRAM



BRASS SPIRIT LAMP

(b) **Burners.** Such appliances in which flame is produced by burning inflammable gases are called burners. They are classified into different types on the basis of the name of the inventor, or nature of the flame or nature of inflammable material.

Examples of common burners are—Bunsen burner, Petrol burner, Fish tail burner, Burthel Spirit burner, Fletcher burner, Argand burner and Blow pipe burner. Out of these burners, we shall confine ourselves to the detailed study of diagrams of—Bunsen Burner.

1. Bunsen Burner

This burner is most commonly used in college laboratories where oil gas required for it is produced by cracking kerosene oil. Drops of the oil are made to fall on a red hot pan and oil gas which is a mixture of lower hydrocarbons is produced. It takes its name from the name of the inventor R. Bunsen.

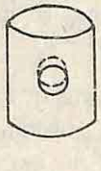
It consists of the following main parts.

(i) Base
(ii) Burner Tube
(iii) Air Regulator

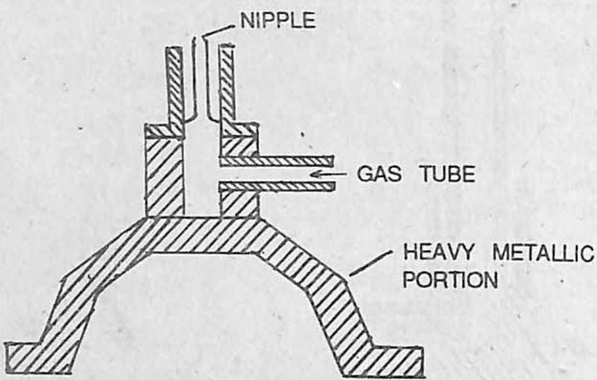
(i) **Base** . It as a whole serves three functions; it stabilises the burner; allows the entry of the oil gas in the burner; releases the gas in the burner tube. Each function is achieved by a separate part. Consequently we say that base consists of three parts.

a. *Heavy Metallic Portion.* Heavy metallic portion which forming the real base serves to make the burner's stand.

b. *Gas Tube.* Near the upper end of the base there is a side inlet tube which has outer screws. They facilitate the tight fitting of rubber tubing over them to avoid leaking of the gas. Rubber tubing connects the gas tube with gas tap and allows the gas to flow to the burner.



Air Regulator with two holes of equal sizes opposite to each other



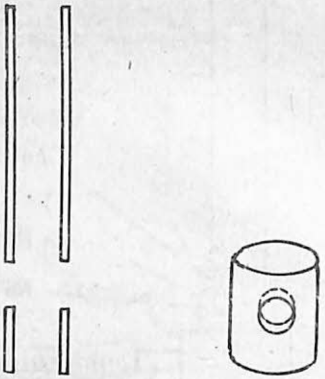
Base with Nipple and Gas Tube

c. *Nipple*. At the top of the base there is a fine nozzle having outer screws. Nipple fits in the base in such a way that the gas from the gas tube passes unrestricted through it and enters the burner tube under pressure.

(*ii*) **Burner Tube.** It is a long metallic tube usually made of brass. It has inner screws at its lower end which fit in the outer screws of the nipple. Near this end there are two holes opposite to each other to allow the entry of air in the burner tube to help combustion. These holes are called air-holes. Burner tube receives gas under pressure at its lower end.

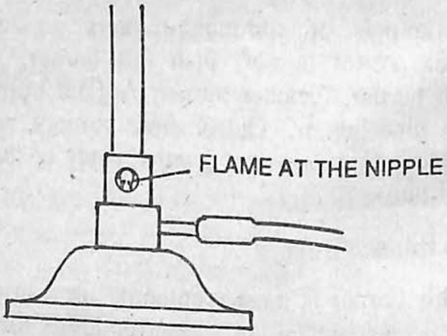
(*iii*) **Air Regulator.** It is a small piece of metallic tube open at both the ends. Inner diameter of the regulator is slightly greater than the outer diameter of the burner tube. It has two circular holes opposite to each other. It easily slips over the burner tube. It enables us to open and close the holes of burner tube at will. Its circular holes coincide with those of the burner tube when oxidising flame is required. When it is rotated in such a way that holes of burner tube are closed, reducing flame results.

Working. At the time of lighting, Bunsen Burner close the holes before opening the gas tap. The gas is burnt at the top of the burner tube by exposing it to the lighting match stick. This will give luminous (reducing) flame. The supply to air is controlled by gradually turning the air regulator to open the hole. With the opening of the hole the flame becomes non-luminous (or oxidising).



Burner tube with two holes opposite to each other

It should be borne in mind by the students that uncontrolled supply of air through the holes would make the gas burn at the nipple instead of at the top of the burner tube. This abrupt burning of the gas at the nipple is called 'striking back of burner'.



Striking Back of Burner

As a result of 'striking back' burner gets heated and is liable to injure the hands of the worker. Should it happen, close the holes by turning the air regulator with the help of tongs after turning off the tap. Now open the tap and light the burner. Make the flame non-luminous by slightly opening the holes so that the flame is noiseless and steady.

EXPERIMENT 1.1

To compare the solubility of Ionic Compound and Covalent Compound (i) in water and (ii) in organic solvents.

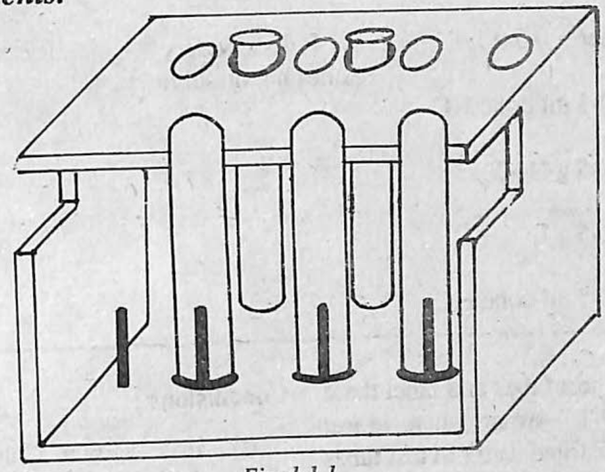


Fig. 1.1.1

Theory : An Ionic Compound is formed by transfer of one or more valence electrons from one atom to another atom in such a way that former acquires positive charge and later one negative charge. After the development of charges these oppositely charged particles (Ions) are held by strong forces of electrostatic attraction. Such compounds are named as Electrovalent or Ionic Compounds, *e.g.* NaCl, KCi, $MgCl_2$ Na_2S.

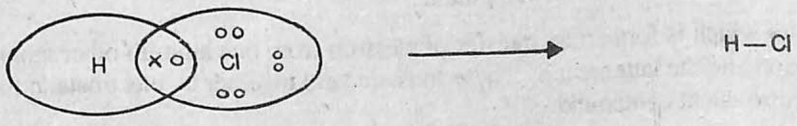
A covalent compound is formed by equal contribution and mutual sharing of electrons between the combining atoms in such a way that each atom acquires a stable configuration of 8 electrons. The electrons pair is shared equally between the two atoms and results in formation of covalent bond. The compound so obtained is named as covalent compound. eg. HCl, Cl_2, H_2, N_2, O_2.

(*i*) Ionic Compounds dissolve in water but these are generally insoluble, in organic solvents like Benzene, Alcohol, Carbon tetra chloride etc.

(*ii*) Covalent Compounds are readily soluble in organic solvents but are usually insoluble in water.

Apparatus Used : Test tubes, Test tube stand, Beaker, Wash bottle etc.

Chemicals Required : Sodium chloride, Iodine, Hydrchloric acid, Distilled water, Benzene.



Single Covalent (Polar Covalent Compound)

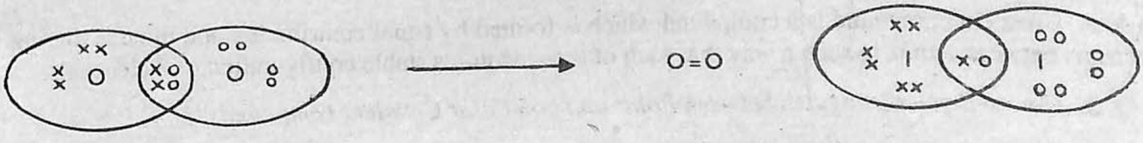


Fig. 1.1.2 Double Covalent (Non-Polar Covalent Compound)

Observation Table

T.T. No.		Experiment	Observation Inference
I	5 ml distilled water + 0·5 g NaCl.	Salt dissolves	NaCl is soluble in H_2O
II	5 ml distilled water + 0·5 g I_2	It dissolves/ does not dissolve	It is soluble or insoluble in water.
III	5 ml dis. H_2O + 0·5 ml conc HC	–	–
IV	5 ml Benzene + 0·5 g NaCl.	–	–
V	5 ml Benzene + 0·5 g I_2	–	–
VI	5 ml Benzene + 0·5 ml conc HCl	–	–

Method : Take six dry test tubes and label these tubes as I, II, III, IV, V, VI. Arrange them in test tube stand. Add 5 ml of distilled water in test tubes I, II, III. In test tube I add 0·5 gm of Sodium Chloride. In test tube II 0·5 gm of Iodine and in Test Tube III 0·5 ml. of HCl. Shake all the three tubes vigorously and record your observations. Likewise take 5 ml of Benzene in test tube IV, V, VI and add NaCl, I_2 and HCl respectively and repeat the process. Record your observations.

Results :

(i) Sodium Chloride is soluble in water but insouble in Benzene.

(ii) I_2 is .... in water but .... in Benzene

(iii) HCl is .... in water but .... in Benzene.

Conclusions :

(i) Since Sodium Chloride is soluble in water and insoluble in Benzene, it is an Ionic Compound.

(ii) Since Iodine (I_2) is .... in water and .... in Benzene, it is an Ionic/a nonpolar Covalent/Polar Covalent Compound.

(iii) Since HCl is .... in water and .... in Benzene, it is an Ionic/a non polar Covalent/Polar Covalent Compound.

Teacher's Activity : A teacher must take other samples of Ionic Compounds and Covalent Compounds. He should treat these with different solvents and ask the students to draw the conclusions by teacher's activity in the Laboratory.

ORAL QUESTIONS

Q. 1. *What is an Ionic or Electrovalent compound ?*

Ans. A compound which is formed by transfer of electron from one atom to other atom in such a way that former form cation and the latter anion. These Ions are held together by electrostatic force of lines. It is also known as Electrovalent compound.

Q. 2. *What is a Covalent compound ?*

Ans. Covalent compound is a compound which is formed by equal contribution and mutual sharing of electrons between atoms in such a way that each of them acquires stable configuration of 8 electrons.

Q. 3. *How will you distinguish between Polar and non Polar Covalent compounds ?*

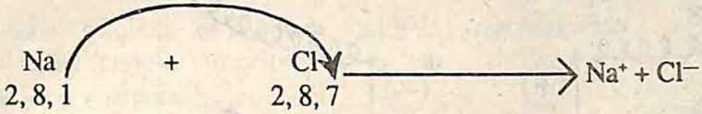
Ans. Covalent compounds are of two types. Polar and non Polar. Polar Covalent compounds furnish ions when dissolved in water (eg. HCl) whereas non polar covalent compounds do not forms ions. *e.g.* Cl_2, I_2, H_2, N_2, etc.

Q. 4. *What is solubility ?*

Ans. Whenever any soluble compound is added to a suitable solvent, its molecules disappear and we say the compound is soluble. The amount of solute dissolved in 100 gm of solvent at a particular temperature is termed its solubility.

Q. 5. *How is an Ionic or Covalent compound formed ?*

Ans. Ionic compound is formed by transfer of electrons from one atom to another atom *e.g.* NaCl is formed by transfer of $1e^-$ from Na to Cl atoms.



$$\underset{2,\,8,\,1}{\mathrm{Na}} + \underset{2,\,8,\,7}{\mathrm{Cl}} \longrightarrow \mathrm{Na^+} + \mathrm{Cl^-}$$

whereas Covalent compound is formed by equal contribution and mutual sharing of electrons between the atoms. *e.g.* H_2, N_2, O_2, Cl_2 etc.

Q. 6. *What is the colour of Iodine in solid state ?*

Ans. Blackish violet shining crystal.

Q. 7. *What is the colour of Iodine solution in Benzene or in CCl_4 ?*

Ans. Violet.

Q. 8. *What is the colour of Iodine Solution in CCl_4 and H_2O ?*

Ans. Violet solution. When water is added two distinct layers can be seen, one of I_2 solution (violet) at the bottom and other of colourless water.

EXPERIMENT 1.2

To study the electrical conductivity of ionic and covalent compounds.

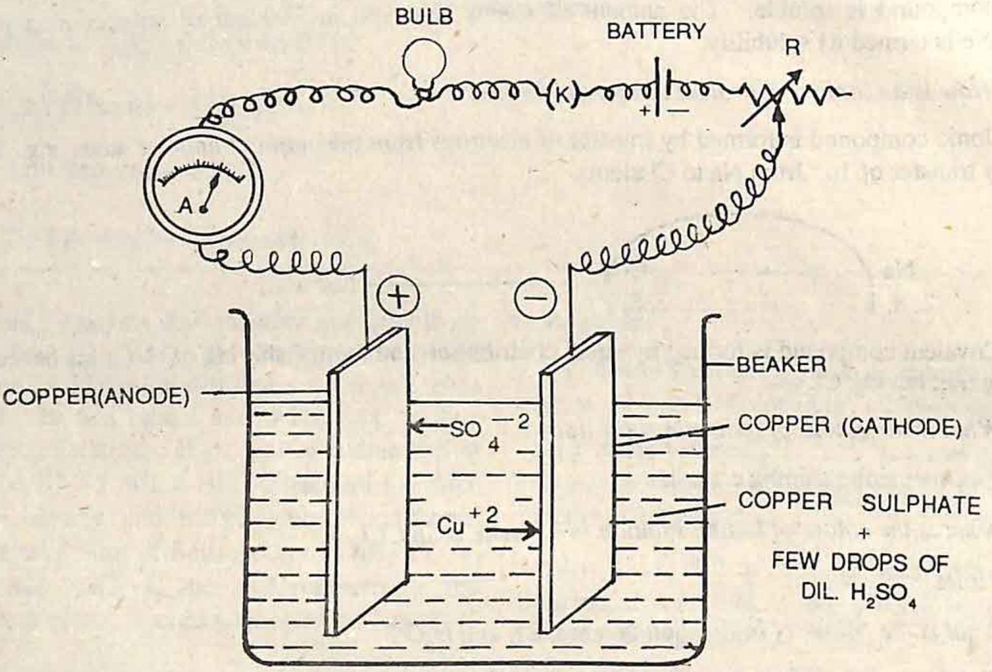


Fig. 1.2

Theory : Those substances which can conduct electric current when passed through their aqueous solution, are called Electrolytes. Whereas those which do not conduct electricity are called Non-electrolytes. For example all ionic compounds dissociate into ions when dissolved in water and their aqueous solution can conduct electricity whereas nonpolar covalent compounds do not furnish ions and therefore they can't conduct current.

Electrolytes	**Non-Electrolytes**
NaCl, KCl, $AgNO_3$	Glucose, Sugar
$CuSO_4$ etc.	Alcohol, Glycerol
(Ionic compounds)	(Covalent compounds)

Apparatus used : Dry cell or battery, torch bulb, beakers, connecting wires.

Chemicals required : Sodium Chloride, Glucose, Distilled Water etc.

Procedure : Prepare aqueous solution of 4 gm of NaCl in 20 ml of distilled water taken in a beaker and mark it I. Prepare another solution of glucose in distilled water and mark it II. Take two Cu plates and connect one of the Cu plate with one end of the dry cell or battery with the help of connecting wire. Connect the other electrode with another end of the battery. A torch bulb is also connected in the circuit as shown in the diagram. Dip these two plates in solution I and record the observations. Remove these electrodes from solution I and dip it in solution II. Pass the current and record the observations, whether bulb glows or not.

Observation Table :

S. No.	*Solutions*	*Observation*	*Inference*
1	Solution I (NaCl)	Bulb glows	It conducts current
2	Solution II (Glucose)	Bulb does not glow	It does not conduct current
3	Solution III ($CuSO_4$)	—	—
4	Solution IV (Sugar)	—	—
5	Solution V (HCl)	—	—

Result :

(1) Aqueous solution of sodium chloride conducts electric current therefore it is an electrolyte or ionic compound.

(2) Aqueous solution of glucose cannot conduct electric current hence it is an nonelectrolyte or covalent compound.

Precautions :

(1) Electrodes (Cu plates) should not touch each other.

(2) Aqueous solution must be prepared in distilled water.

Teacher's Activity : The teacher should select 4 ionic compounds and 4 covalent compounds and the experiment should be demonstrated in laboratory. Thus the students can predict the results by these experiments. Instead of torch bulb electric bell can also be used.

ORAL QUESTIONS

Q. 1. *What is an electrolyte ?*

Ans. Those substances which can conduct electric current when passed through aqeuous solution or fused mass, are termed as electrolytes *e.g.* NaCl, KI, NaOH, KOH etc.

Q. 2. *What is a non-electrolyte ?*

Ans. Those substances which do not conduct current are termed as non-electrolytes *e.g.* (All nonpolar covalent compounds) CCl_4, $CHCl_3$, Glucose, Sugar etc.

Q. 3. *How does an electrolyte or ionic compound conduct current ?*

Ans. Ionic compounds dissociate into ions in aqueous solution or in fused state. Thus they can conduct current because ions are set free in this fused state.

Q. 4. *Why do covalent compounds not conduct current ?*

Ans. Covalent compounds (nonpolar) do not furnish ions.

Q. 5 . *What about polar covalent compounds ? Do they conduct current or not ?*

Ans. Polar covalent compounds can conduct current because these compounds can produce ions when dissolved in water *e.g.* HCl is polar covalent compound and on dissolving in water it gives Hydronium ion and chloride ion.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Q. 6. *What is an electrode ?*

Ans. An electrode is a metallic rod which is electron-rich or electron-poor and is connected to the terminal of a battery.

Q. 7. *What is an anode ?*

Ans. Anode is an electrode at which oxidation takes place.

Q. 8. *What is a cathode ?*

Ans. A cathode is an electrode where reduction occurs.

Q. 9. *Why do we use distilled water ?*

Ans. Distilled water is the purest form of water and does not contain any impurity of ions.

EXPERIMENT 1.3

To determine the melting point of given solid substance.

Theory : The temperature at which a solid substance starts melting, is known as its melting point. At the melting point, solid and liquid phases exist together at atmospheric pressure. It has been observed that ionic compounds or electrovalent compounds have high melting points whereas covalent compounds have low melting points.

Apparatus used : Capillary tube, Watch glass, Thermometer, Iron stand with clamp, Tripod stand, Wire gauze, Stirrer and Beaker.

Chemicals required : Sodium Chloride, Naphthalene, Urea.

Procedure : Take a fine glass capillary tube about 5 cm long and seal one of its end by heating it in the flame—giving rotations to the capillary tube.

Powder the solid substance as fine as possible. Take the fine powder on a watch glass. Introduce a little of the dried powdered substance in the capillary tube by tapping it gently.

Attach this capillary tube to the thermometer by moistening it with water or paraffin oil and with rubber band. Now place the thermometer attached with capillary tube in the beaker containing oil or water or sulphuric acid. Raise the temperature slowly with constant stirring. Note the temperature at which the substance first melts. Remove the burner. Allow the beaker to cool and again note the temperature at which the substance solidifies. If there is a slight difference in the two readings then the mean of the two readings is taken. If no difference is there, the first reading may be taken as the melting point of the solid.

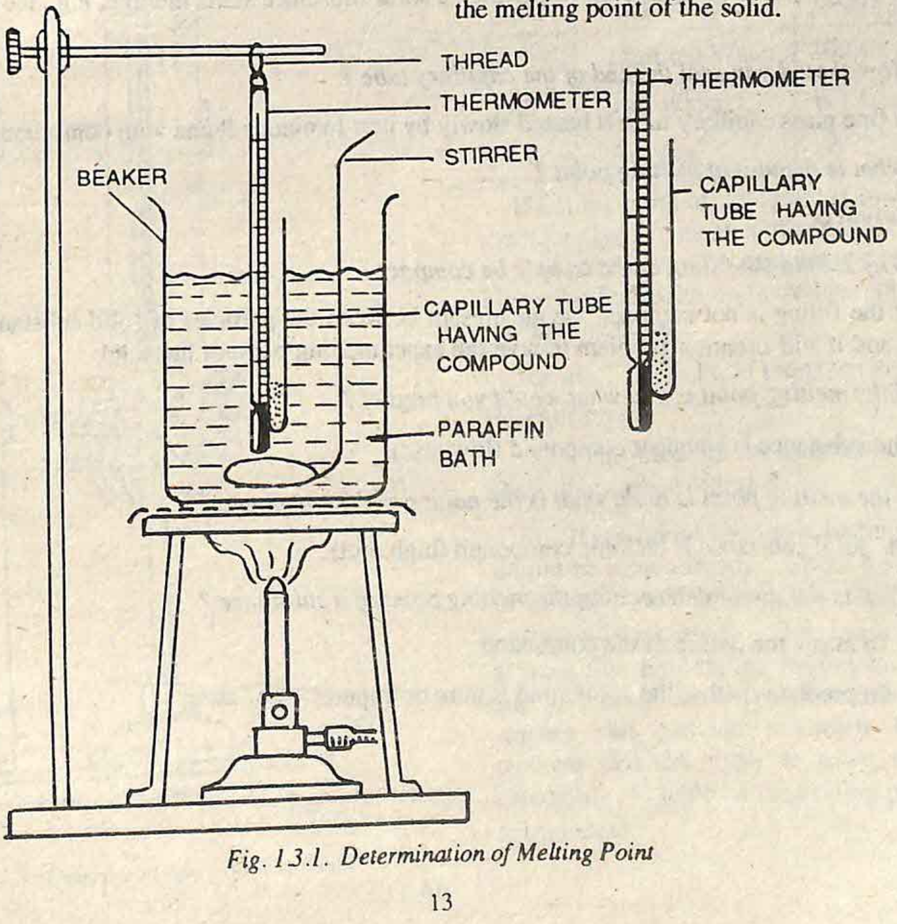

THREAD
THERMOMETER
STIRRER
BEAKER
CAPILLARY TUBE HAVING THE COMPOUND
PARAFFIN BATH
THERMOMETER
CAPILLARY TUBE HAVING THE COMPOUND

Fig. 1.3.1. Determination of Melting Point

Observations :

(1) The temperature at which the solid substance starts melting $= t_1$°c.

(2) The temperature at which the substance solidifies $= t_2$°c.

(3) The melting point of substance $= \frac{[t_1 + t_2]}{2}$

(If t_1 and t_2 are very close to each other.)

Result & Conclusion : The melting point of compound is t°c. If it is low the compound is covalent otherwise it is an ionic compound.

Precautions :

(1) Sealing of capillary tube should be done carefully.

(2) The bulb of thermometer and end of tube with the substance should be dipped in water, oil or conc. H_2SO_4.

(3) The solid powder must be filled carefully as compact as possible.

(4) Heating should be slow.

(5) If melting point of substance is above 100°C, conc. H_2SO_4 or paraffin oil should be used.

Teacher's Activity : The teacher must demonstrate the experiment with three samples having m.pts. less than 100°C, and more than 100°C but less than 200° by using all three mediums—water, oil and conc. H_2SO_4.

ORAL QUESTIONS

Q. 1. *Define melting point.*

Ans. Melting point is the temperature at which a solid substance starts melting, *e.g.*, ice melts at 0°C or 273K.

Q. 2. *How should you seal the end of the capillary tube ?*

Ans. A fine glass capillary tube is heated slowly by non-luminous flame with continuous rotation.

Q. 3. *What is the unit of melting point ?*

Ans. Kelvin or °C.

Q. 4. *Why should the filling of the sample be compact ?*

Ans. If the filling is not compact, the air present between the particles of solid substance will expand on heating and it will create a problem to note the exact melting point of the solid.

Q. 5. *If the melting point is low what would you predict ?*

Ans. The substance is covalent compound (low mpt).

Q. 6. *If the melting point is high, what is the nature of the compound ?*

Ans. The solid substance is an ionic compound (high mpt).

Q. 7. *What is the use of determining the melting point of a substance ?*

Ans. 1. To know the nature of the compound.

2. To predict whether the compound is pure or impure.

EXPERIMENT 1.4

To determine the boiling point of a given liquid substance.

Theory : The temperature at which the vapour pressure of a liquid becomes equal to atmospheric pressure, is termed as Boiling Point of a liquid. At the boiling point the liquid starts boiling. Whenever a liquid is supplied heat, its molecules gain energy and vapours are formed. On further heating more vapours are formed and the pressure of vapours becomes equal to the atmospheric pressure. Under these conditions the liquid starts boiling.

Apparatus used : Hard glass test tube, thermometer, Iron stand with clamp, Wire gauze Cork, Delivery tube, Pieces of pumice stone.

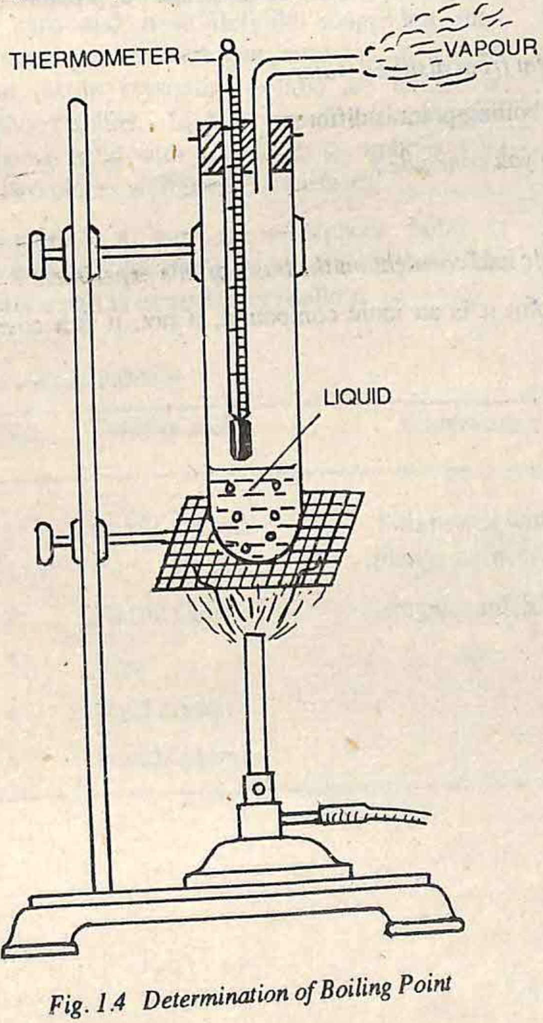


Fig. 1.4 Determination of Boiling Point

Chemicals required : Distilled water, Tap water, Acetone, Benzene *etc.*

Procedure : Take the sample of liquid whose boiling point is to be determined in the hard glass test tube. Fit in its mouth a rubber cork having two holes. In one of the hole a thermometer is inserted and in another hole a delivery tube is fitted. Few pumice stones are added initially in the glass tube. The tube is clamped and heated slowly and continuously with the help of burner. The bulb of thermometer should be kept first above the surface of the liquid. After some time the liquid starts boiling and a few vapours come out of the delivery tube. When the level of mercury in thermometer becomes constant, the reading is recorded.

Observation Table :

S. No.	*Name of liquid*	*B.Pt.*	*Inference*
1	Distilled Water	100°C.	
2	Tap Water	101°C.	
3	Acetone	56°C.	

If boiling point of the liquid is low it means that the liquid is a covalent compound. If it is high it is an ionic compound because ionic compounds have higher boiling point and covalent compounds have low boiling point.

Result : The B.Pt. of the given liquid is ....

Precautions :

(1) The bulb of the thermometer should be above the surface of liquid.

(2) If the liquid has a low boiling point, heating should be done directly. Either a wire gauze or a water bath should be used.

Teacher's Activity : The teacher should select at least two liquids, one having low boiling point and the other having high boiling point. The teacher can provide unknown liquids to the students and ask them to name the liquid after consulting the table on the boiling points of various substances.

ORAL QUESTIONS

Q. 1. *What is the Boiling Point ?*

Ans. Boiling Point is the temperature at which the vapour pressure of a liquid is equal to the atmospheric pressure and the liquid starts boiling.

Q. 2. *Define the vapour pressure.*

Ans. The pressure exerted because of vapours of liquid is termed as vapour pressure.

Q. 3. *Why do you use pumice stone pieces ?*

Ans. To prevent spurting.

Q. 4. *Why should the bulb of thermometer dip in the liquid ?*

Ans. If not dipped in the liquid the bulb of thermometer may break up.

Q. 5. *What is the use of the delivery tube ?*

Ans. Vapours may escape out of the delivery tube. If they are not allowed to escape out pressure inside the tube will increase.

Q. 6. *Why is the boiling point of tap water different from distilled water ?*

Ans. Tap water contains impurities, therefore its boiling point is different.

Q. 7. *If the boiling point of liquid is low, what do you conclude ?*

Ans. The liquid is a covalent compound.

Q. 8. *How do you classify the substances into ionic and covalent on the basis of this experiment ?*

Ans. If the given sample has a high boiling point it is an ionic compound, if not, it is a covalent compound.

EXPERIMENT 1.5

To study the nature of crystalline and amorphous substances .

Theory : Solids have a definite shape and size. Mild distorting forces are not able to change their shape because solids are rigid and incompressible. There are two types of solids—crystalline and amorphous.

(A) *Crystalline solids* : Those solids in which constituent molecules, atoms or ions are arranged in a definite geometrical configuration in three dimensioned network, are called crystalline solids. Each crystal has a definite set of plane surfaces *i.e.* on cutting with a knife a crystalline solid gives two pieces with plane surfaces.

(B) *Amorphous solids* : Those solids which are rigid, hard and have definite shape but their constituent particles are not arranged in regular fashion (as in crystalline solids) are termed as amorphous solids. In other words on cutting an amorphous solid with a knife an amorphous solid gives two pieces with irregular surfaces.

Sometimes a part of amorphous solid is crystalline and remaining is non crystalline. The crystalline part is termed as crystallole.

Apparatus and Chemicals : Knife, Copper Sulphate Crystal, Plastic Cube.

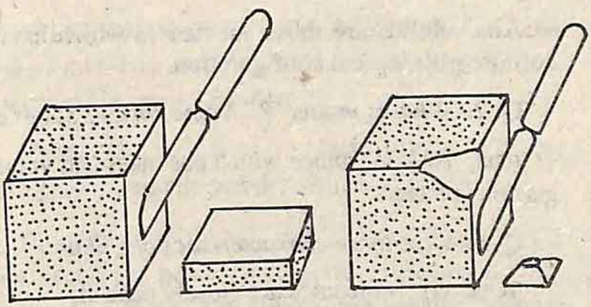


Fig. 1.5 Copper Sulphate Crystals

Procedure : Take the crystal of copper sulphate and cut it carefully with a sharp edged tool like knife. Then take the plastic cube and repeat the process. Record your observations.

Observation Table :

S. No.	*Name of solid*	*Observation*	*Inference*
1	$CuSO_4$ crystal	Two pieces with clean planar surfaces are obtained.	*Substance is crystalline*
2	Plastic Cube	Irregular surface is obtained.	*Solid substance is amorphous*
3	Sugar	—	—
4	NaCl crystal	—	—
5	Potash Alum	—	—

Result and Conclusion : Copper sulphate is crystalline substance and plastic cube is an amorphous substance because in case of Copper sulphate two pieces with plane surfaces are obtained on cutting with a knife whereas in case of plastic cube two pieces with irregular surfaces are obtained.

Teacher's Activity : Teacher should demonstrate this experiment after selecting different crystalline solids and amorphous solids so that students can apply this knowledge to classify various substances.

ORAL QUESTIONS

Q. 1. *What are solids ?*

Ans. Solids are those substances which have a definite shape and their constituents are arranged in definite geometrical configuration.

Q. 2. *What is matter ? Name various states of matter.*

Ans. Any substance which has mass and volume is termed as matter. Matter exists in solid, liquid and gaseous phase.

Q. 3. *Give three characteristics of solids.*

Ans. (i) Molecules are closely packed.

(ii) Molecules are fixed.

(iii) Molecules are associated with minimum energy.

Q. 4. *How do amorphous solids differ from crystalline solids ?*

Ans. In crystalline solids the constituent particles are arranged in a regular fashion whereas in amorphous solids they are not.

EXPERIMENT 1.6

To distinguish between a physical and chemical change.

Theory : Change is a rule of nature. We observe many changes around us. Some are physical and others are chemical.

(A) *Physical change* : A temporary change in which identity of a substance does not change, is called physical change. It is a reversible change and no new substance is formed, *e.g.*, melting of ice is an example of physical change because chemical formula of ice and water is H_2O. Likewise mixing of iron pieces and sulphur powder is a physical change because no new substance is formed and mixture of iron and sulphur powder shows properties of iron as well as sulphur. Some other physical changes are: powdering of sugar, dissolution of sugar in water, vapourisation of water etc.

(B) *Chemical change* : A permanent change in which identity of a substance changes, is called chemical change. It is an irreversible change and new substance with different properties is formed, *e.g.*, burning of magnesium wire. Mg wire burns in excess of O_2 to form Magnesium Oxide with liberation of heat and light and produces a new substance Magnesium Oxide where properties of Magnesium and Oxygen are lost. Some other chemical changes are: burning of a candle, souring of milk, heating of iron and sulphur, rusting of iron, heating of sugar etc.

Apparatus used : Beaker, Watch glass, China dish, Test tubes, Burner, Tripod stand, Wire gauze, Glass rod, Magnet, Grinder.

Chemicals required : Iron filings, Carbon disulphide, Sulphur powder, dilute sulphuric acid.

Procedure : Take 2 gms of iron filings and 2 gms of sulphur powder in a grinder and mix it well. It is a mixture of iron filings and sulphur powder and it is marked as sample I.

Take 2 gms of iron filings and 1 gm of sulphur powder in a China dish and heat it over burner with continuous stirring till a blackish mass of iron sulphide is obtained. Cool the black mass of iron sulphide and powder the black mass with the help of a spatula and mark it sample II. Perform the following experiments and record your observations.

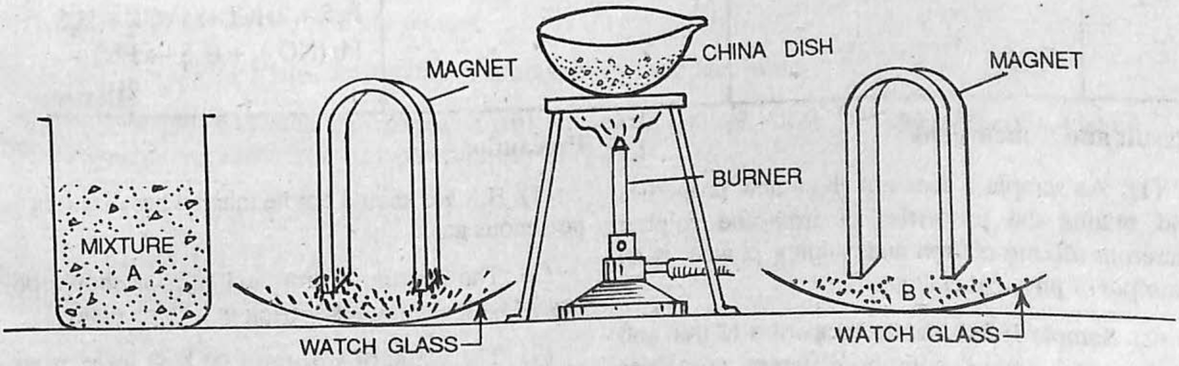


Fig. 1.6

Observation Table :

S. No.	*Experiment*	*Observations*	*Inference*
1	Take from sample I in a dry test tube and add carbon disulphide. Stir it	Sulphur dissolves but reappears after evaporation of CS_2.	Sulphur retains its properties on mixing.
2	Take from sample II in a dry test tube and add CS_2.	No change is observed.	Sulphur has lost its properties on heating it with iron.
3	Bring a magnet over a little amount of sample I.	Iron filings cling to the magnet.	Iron retains its properties on mixing.
4	Move the magnet over a little amount of sample II.	No change is observed.	Iron has lost its properties in sample II.
5	Take from sample I in test tube and add dil. HCl.	A gas is liberated which burns with a pop sound.	Iron reacts with dil. HCl to form H_2 gas. Hence iron retains its properties. $Fe + 2HCl \rightarrow FeCl_2 + H_2\uparrow$
6	Take from sample II in a test tube and add dil. HCl.	A colourless gas with a fishy odour is obtained.	Sample II (FeS) reacts with dil. HCl to form Hydrogen sulphide which gives black ppt of Lead sulphide with Lead nitrate. Thus the new substance Iron sulphide has different properties, $FeS + 2HCl \rightarrow FeCl_2 + H_2S$ $Pb(NO_3)_2 + H_2S \rightarrow PbS + 2HNO_3$
7	Pass this gas through Lead nitrate.	A black ppt. of lead sulphide is obtained.	

Result and Conclusions :

(1) As sample I does not show new properties and retains the properties of iron and sulphur therefore mixing of Iron and Sulphur powder is an example of physical change.

(2) Sample II has lost the properties of iron and sulphur and shows entirely different properties therefore heating of iron filings and sulphur powder is a chemical change.

Precautions :

(1) H_2S gas should not be inhaled because it is a poisonous gas.

(2) The mixture of iron and sulphur should be heated with continuous stirring in a china dish.

(3) The bottle of CS_2 must be kept away from the flame because it can catch fire.

Teacher's Activity : The teacher can take a sample of sugar and dissolve in water and perform certain experiments in the laboratory to prove that dissolution of sugar is an example of physical change. Likewise burning of candle is an illustration of chemical change. Many more examples from everyday life can be discussed in the laboratory to distinguish a physical change from a chemical change.

ORAL QUESTIONS

Q. 1. *Define a physical change.*

Ans. Physical change is a temporary change in which the identity of a substance does not change.

Q. 2. *Define a chemical change.*

Ans. Chemical change is a permanent change in which the identity of a substance changes.

Q. 3. *Distinguish a physical change from a chemical change.*

Ans. In a physical change no new substance is formed whereas in a chemical change new product is formed, *e.g.* Melting of Ice is a physical change because chemical formula of Ice and Water is H_2O (i.e. no new product is formed) whereas burning of candle is a chemical change where new products CO_2 and water vapours are formed and from these products the candle can not be obtained back.

Q. 4. *Classify the following into physical or chemical changes. Give one reason.*

(i) Mixing sugar in tea
(ii) Breaking of glass apparatus
(iii) Formation of curd from milk
(iv) Melting of wax
(v) Burning of candle
(vi) Rusting of iron
(vii) Burning of cooking gas
(viii) Heating of platinum wire
(ix) Rise of mercury in thermometer
(x) Dissolving soaps, detergent or shampoo in soft and hard water.

Ans. (i) Chemical change, (ii) physical, (iii) chemical, (iv) physical, (v) chemical, (vi) chemical, (vii) chemical, (viii) physical, (ix) physical, (x) chemical.

Acc no. 15226

EXPERIMENT 1.7

To classify the reactions as exothermic and endothermic by measuring temperature change during the reaction.

Theory : Whenever a physical or chemical change takes place, heat is either evolved or absorbed. Those reactions in which heat is evolved are called exothermic reactions and heat so liberated increases the temperature of surroundings.

Those reactions in which heat is absorbed are termed as endothermic reactions and the heat absorbed in an endothermic change decreases the temperature of the surroundings, *e.g.*,

(1) Addition of conc. Sulphuric acid to water is an example of exothermic reaction in which heat is liberated and the container becomes hot.

(2) Spraying of water over lime liberates heat (exothermic reaction).

(3) Whenever a strong base is added to an acid, heat is liberated (exothermic reaction).

(4) Dissolution of Ammonium chloride in water is an example of endothermic reaction because the test tube becomes cooler.

(5) Evaporation of water (endothermic reaction).

(6) Evaporation of alcohol, ether (endothermic reaction).

Let us study a few exothermic and endothermic reactions.

(A) To measure the change in temperature in the reaction between conc. nitric acid and sodium hydroxide :

Apparatus used : Measuring cylinder, conical flask, thermometer, stand with clamp and stirrer.

Solutions used : 20 ml. of HNO_3 of 1 molar, 20 ml. of NaOH of 1 molar.

Procedure : Take 20 ml of NaOH in a measuring cylinder and note its temperature with the help of thermometer. Then take 20 ml of HNO_3 acid in a conical flask. Note its temperature with another thermometer. Dip this thermometer in HNO_3 acid and clamp it. Add 20 ml. of base NaOH from measuring cylinder slowly and slowly into conical flask and stir the mixture and note the temperature of the solution. Record your observations.

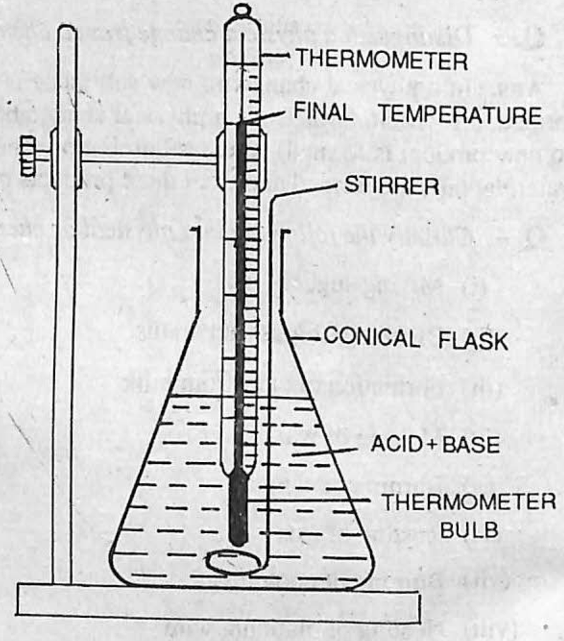


Fig. 1.7

Observation Table :

S. No.	*Temp. of NaOH*	*Temp. of HNO_3*	*Initial temp.*	*Temp. of solution*
1	t_1^0C	t_2^0C	$\frac{t_1+t_2}{2}$ $= t_3^0C$	$t_4^0C.$

Change in temp. $\Delta T = [t_4^0C - t_3^0C.]$

Result and Conclusions : If ΔT is negative, the reaction is exothermic if not it is endothermic.

The reaction can be explained as follows :

$$\underset{(aq)}{HNO_3} + \underset{(aq)}{NaOH} \rightarrow NaNO_3 + H_2O + \text{Heat}$$

Precautions :

(1) The solution should be stirred well.

(2) The temperature should be recorded carefully.

(3) Thermometer should be dried before dipping into acid or base.

(4) Both the acid and base should have same concentration to get better results.

(B) To measure the temperature when conc. Sulphuric acid is dissolved in water.

Apparatus used : Conical flask, stirrer, thermometer and stand with clamp.

Solution used : Conc. H_2SO_4 or any conc. acid and distilled water.

Procedure : Take 50 ml of distilled water in a conical flask. Clamp the thermometer and dip the bulb of thermometer in the beaker having a glass stirrer. Add 2 ml. to 5 ml. of conc. H_2SO_4 drop by drop with stirring. Note the temperature and find the change in temperature. Instead of conc. H_2SO_4, conc. HCl or conc. HNO_3 can also be used. This is the method to dilute an acid. If there is increase in temperature, the reaction is said to be exothermic otherwise endothermic.

Observations :

(1) Temperature of distilled water = t_1°C.

(2) Final temperature of solution = t_2°C.

(3) Change in temperature $\Delta t = (t_2 - t_1)$

Result : When conc. H_2SO_4 is added to water, heat is liberated, so dissolution of conc. H_2SO_4 is an example of exothermic reaction.

(C) To measure change of temperature on dissolving Ammonium chloride in water.

Apparatus used : Conical flask, stirrer, thermometer, stand with clamp.

Chemicals used : Distilled water, solid Ammonium chloride.

Procedure : Same as in (B)

Observations :

(1) Initial temperature = t_1°C.

(2) Final temperature = t_2°C.

(3) $\Delta t = t_2 - t_1$

Result : When NH_4Cl is added to water heat is absorbed so it is an example of endothermic reaction.

Teacher's Activity :

(1) Instead of NH_4Cl, other salts can be taken and on repeating the experiment conclusion can be drawn to classify the reaction as exothermic and endothermic.

(2) Neutralization of any acid with any base can be studied.

(3) Reaction between any metal and salt solution can be studied (like Fe and $CuSO_4$).

ORAL QUESTIONS

Q. 1. *What are exothermic reactions ?*

Ans. Those reactions in which heat is evolved are known as exothermic reactions, *e.g.*

$$C + O_2 \rightarrow CO_2 + \text{Heat (393.5 KJ mol.)}$$

Q. 2. *What is an endothermic reaction ?*

Ans. The reaction in which heat is absorbed, *e.g.*

$$N_2 + O_2 \rightarrow 2NO - \text{heat (180 KJ)}$$

Q. 3. *What is the application of exothermic and endothermic reactions ?*

Ans. Exothermic reactions provide energy, *e.g.*, when coke burns, heat energy is liberated. It can be used for cooking.

In our body, glucose (carbohydrate) undergoes oxidation (during respiration) and liberates energy which is used for various activities.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Heat.

Evaporation of water is an endothermic reaction. Using this property the desert coolers give relief to us in summer by lowering the temperature of the system (room).

EXPERIMENT 1.8

To construct a valtaic cell.

Theory :

(A) Voltaic cell (an Electro-chemical cell) is a device by which chemical energy is converted into electrical energy.

(B) *Ion* : Ion is a charged particle. If it carries positive charge it is said to be cation. If an ion carries negative charge, it is termed as anion.

(C) *Oxidation* : It is a process involving loss of electron (De-electronation).

(D) *Reduction* : It is a process involving gain of electron (Electronation).

(E) *Anode* : It is an electrode where oxidation takes place.

The simple voltaic cell consists of a vessel or a beaker containing dilute sulphuric acid in which two electrodes are dipped. One is zinc and the other is copper. Zinc loses electron and forms zinc ion. As oxidation is taking place at zinc electrode, it is termed as the anode. It is electron rich and negative polarity can be assigned to it.

At zinc electrode,

$$Zn - 2e^- \rightarrow Zn^{+2}$$

Oxidation

$$Zn + H_2SO_4 \rightarrow Zn^{+2}SO_4^{-2} + 2H^+$$

At Cu Electrode,

$$2H^+ + 2e^- \rightarrow [2H] \rightarrow H_2\uparrow$$

Reduction

At copper electrode hydrogen ion gains electrode so copper electrode is termed as cathode (because of reduction).

Apparatus used : Zinc rod, Copper rod, Connecting wires, Voltmeter.

Solution used : Dilute Sulphuric Acid.

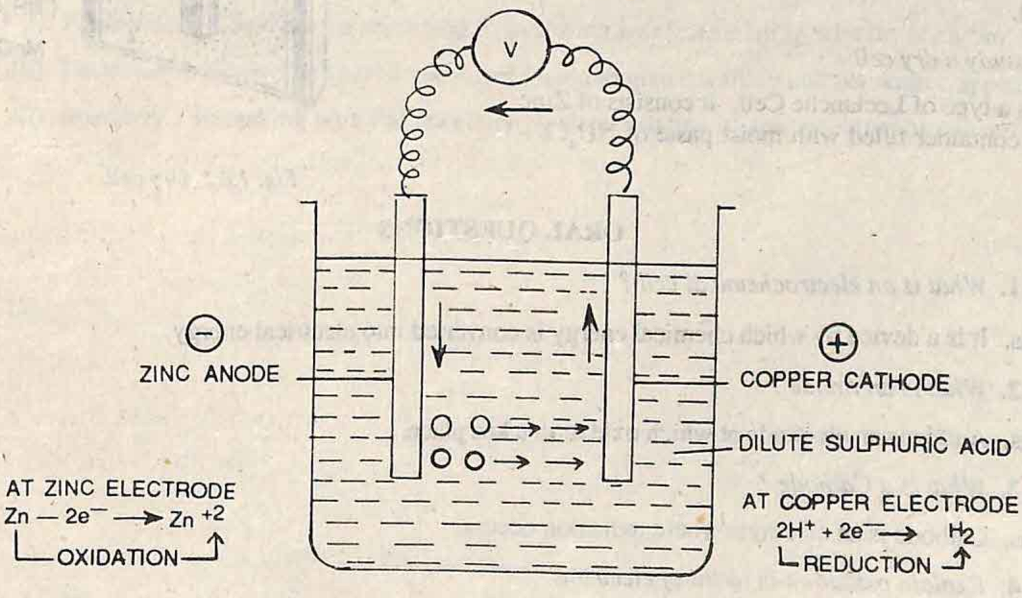


Fig. 1.8.1

Procedure : Take dilute sulphuric acid in a beaker and dip zinc and copper rods in dil. H_2SO_4 acid. Connect these electrodes with the help of a wire and insert a voltmeter in the circuit as shown in the diagram. Zinc starts reacting and bubbles of Hydrogen begin to accumulate on the copper electrode.

In this cell electrons flow from zinc electrode through the wire to the copper electrode, where Hydrogen ions gain these electrons and get changed into Hydrogen gas. Record the readings.

Result : The voltage of voltaic cell is ...... volts.

Teacher's Activity : The teacher can assemble an electrochemical cell and can show glowing of torch bulb by using zinc plate dipped in $ZnSO_4$ and Cu plate dipped in $CuSO_4$ solution. These solutions should be taken in two separate beakers. Zinc and Cu plates are connected with external wire. Zinc half cell is joined with Copper half cell with the help of salt bridge which is a glass tube filled with agar agar gel having an inert electrolyte like KNO_3. On connecting these two half cells internal circuit is completed and the reading is recorded in the voltmeter. A torch bulb can also be lighted.

To study a dry cell :

It is a type of Leclanche Cell. It consists of Zinc Metal container filled with moist paste of NH_4Cl + $ZnCl_2$. Zinc Metal acts as Anode. The cathode is a carbon rod or Graphite rod which runs down the centre of the cell usually terminating with a Metal Cap. The name dry cell is derived from the fact that cell is sealed with pitch or wax. Its voltage is 1.25 to 1.50 volts which can cause the glow of torch bulb or to run a motor in toys.

Reactions taking place can be written as follows.

At Anode $Zn - 2e^- \rightarrow Zn^{+2}$

Oxidation

At Cathode (Reduction)

$$2NH_4^+ + 2\,MnO_2 + 2e^- \rightarrow 2NH_3 + H_2O + Mn_2O_3$$

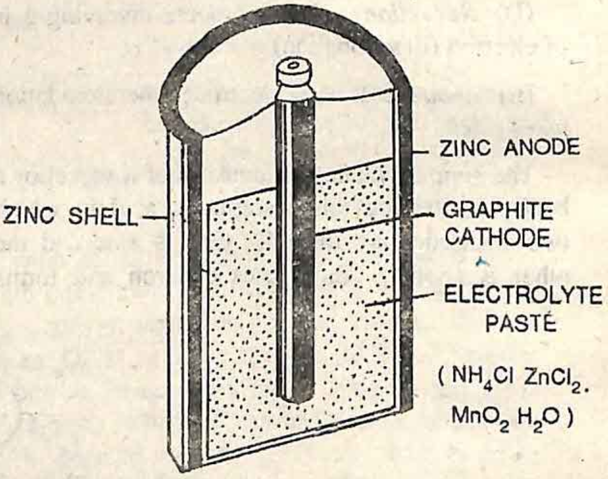


Fig. 1.8.2 Dry cell.

ORAL QUESTIONS

Q. 1. *What is an electrochemical cell ?*

Ans. It is a device by which chemical energy is converted into electrical energy.

Q. 2. *What is an Anode ?*

Ans. Anode is an electrode at which oxidation takes place.

Q. 3. *What is a Cathode ?*

Ans. Cathode is an electrode where reduction occurs.

Q. 4. *Explain oxidation in terms of electrons.*

Ans. Oxidation is the process in which loss of electrons takes place.

Q. 5. *Define reduction.*

Ans. Reduction is the reaction which involves a gain of electrons.

Q. 6. *What is a salt bridge ?*

Ans. Salt Bridge is a glass tube filled with agar agar gel containing an inert electrolyte like KNO_3. It completes the internal circuit in an electrochemical cell.

Q. 7. *What is the reaction at the anode ?*

Ans. $$\underset{\text{oxidation}}{Zn - 2e^- \rightarrow Zn^{+2}}$$

Q. 8. *What is the reaction at the cathode ?*

Ans. $$\underset{\text{reduction}}{Cu^{+2} + 2e^- \rightarrow Cu}$$

Q. 9. *What is the net reaction ?*

Ans. $$\underset{\text{oxidation}}{Zn + Cu^{+2} \rightarrow Zn^{+2} + Cu}$$

Q. 10. *What are redox reactions ?*

Ans. Those reactions in which oxidation and reduction take place simultaneously are known as redox reactions. For example Zn is oxidised to Zinc ion and Cu ion is reduced to Cu.

Q. 11. *What is the use of electroplating ?*

Ans. (i) Preservation : Iron can be prevented from rusting by electroplating with tin or chromium.

(ii) Decoration : Copper tea set can be silver plated to give it a shiny and decorative appearance.

(iii) Jewellery : In making artificial jewellery by electroplating of gold on silver ornaments.

EXPERIMENT 1.9

To study the amount of metal deposited at cathode by passing current.

Theory : Michael Faraday deduced the second law of electrolysis in 1834. According to it "The weight of an ion liberated at an electrode is directly proportional to the quantity of current passed through it."

If C amperes current is passed for t seconds and W is the weight of ion liberated. Then, mathematically

$$W \alpha C \times t$$

$$W = Z \times C \times t$$

where Z is the electrochemical equivalent,

If C = 1 amp., t = 1 sec.

$$W = Z$$

So the electrochemical equivalent can be defined as weight of ion liberated by passing 1 ampere current for 1 second. It has been observed experimentally that 1 Faraday or 96,500 Coulombs can deposit 1 gram equivalent of the substance $Z \times 96500$ = gram equivalent.

Apparatus used : Beaker, Zinc rod, Zinc plate Connecting wires, Ammeter, 6 Volt battery, Rheostat, Key, Sand paper, Weight box and Chemical balance, $ZnSO_4$ solution.

Procedure : Take a zinc plate and weigh it accurately after cleaning with sand paper. Take the solution of zinc sulphate in a beaker. The zinc plate is connected to the negative pole of batterty and the zinc rod to the positive pole. Dip these two electrodes in $ZnSO_4$ solution. Key and ammeter are also connected in a circuit. Press the key and pass current for 15-20 minutes. Remove the zinc plate after passing current. Dry it and weigh it accurately. Record the observations.

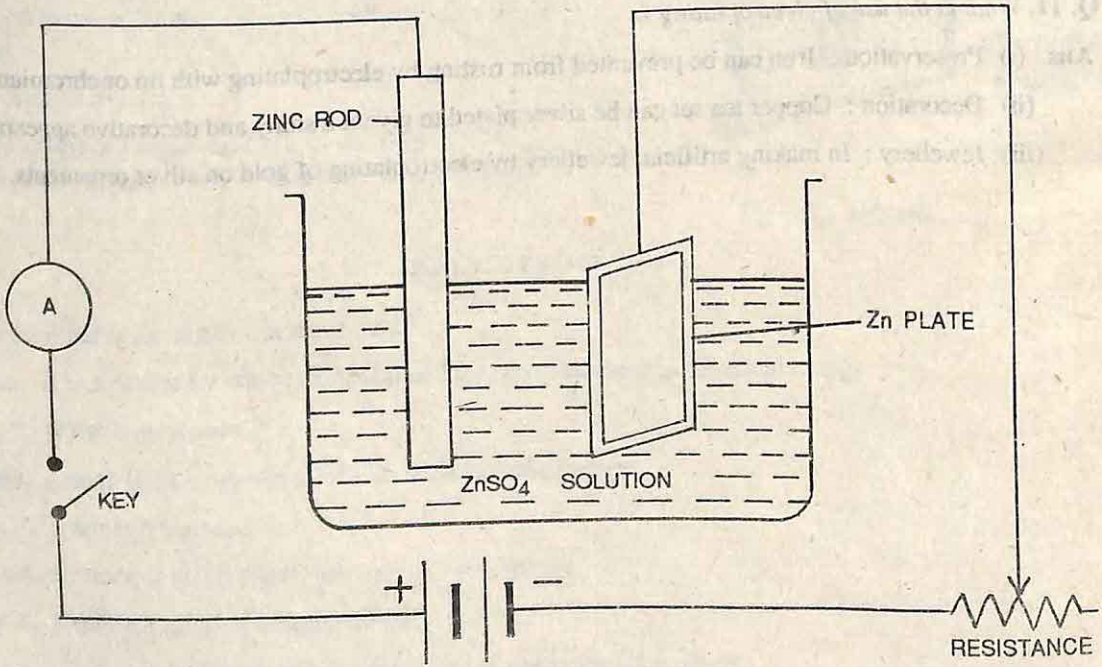


Fig. 1.9

Observations and Calculations :

(1) Current passed in amperes = C amp.

(2) Time in seconds for which the current is passed = t sec.

(3) Mass of zinc plate (initial) = W_1 gms.

(4) Mass of zinc plate (final) = W_2 gms.

(5) Wt of zinc deposited = $(W_2 - W_1)$ = W gms.

Result and Conclusion : Thus by passing C amp. current for t seconds through a solution of $ZnSO_4$, W gram of zinc is deposited.

ORAL QUESTIONS

Q. 1. *What is electrolysis ?*

Ans. It is the process by which an electrolyte decomposes into different products by the passage of electric current.

Q. 2. *Which ion move towards cathode on electrolysis ?*

Ans. Cation (positively charged particle) moves towards cathode.

Q. 3. *Which ion migrate towards anode on electrolysis ?*

Ans. Anion (negatively charged particle) move towards anode.

Q. 4. *What is the unit of charge ?*

Ans. The unit of charge is Coulomb.

Q. 5. *What is the unit of Current ?*

Ans. The unit of current is ampere.

Q. 6. *How many coulombs are in one Faraday ?*

Ans. 1 Faraday = 96,540 Coulombs.

Q. 7. *What is the relation between current and charge ?*

Ans. Coulomb = current in amperes × time in seconds.

EXPERIMENT 1.10

To electroplate nickel over copper.

Theory : Electroplating is a process in which a superior metal can be deposited over baser metal by passing electric current. It is used in protecting iron from rusting, in making cheap jewellery and articles made up of copper are electroplated with gold or silver to enhance their beauty.

The article which is to be electroplated is made as the cathode whereas the metal which will be deposited, is made as the anode. Anode and cathode are dipped in an electrolyte which is a solution of salt of the metal to be deposited. On passing current the metal gets deposited on the article and equal amount of the metal goes into solution from anode.

Requirements : Beaker, Nickel anode, Copper fork as cathode, Nickel ammonium sulphate solution, Battery.

Procedure : Take Nickel ammonium sulphate solution in a beaker. Ni rod or sheet is connected to positive pole whereas copper fork is connected to negative pole. Pass electric current. On passing electric current, Nickel gets deposited on the copper fork and equivalent amount of Ni dissolves from anode into the electrolytic solution.

Result : Copper fork looks silvery because Ni is deposited over Copper. (Electroplating can be done with superior metal over baser metal by same process.)

Teacher's Activity : As silver salts are very expensive so demonstration can be done in laboratory for one small article by Ag wire by using same method.

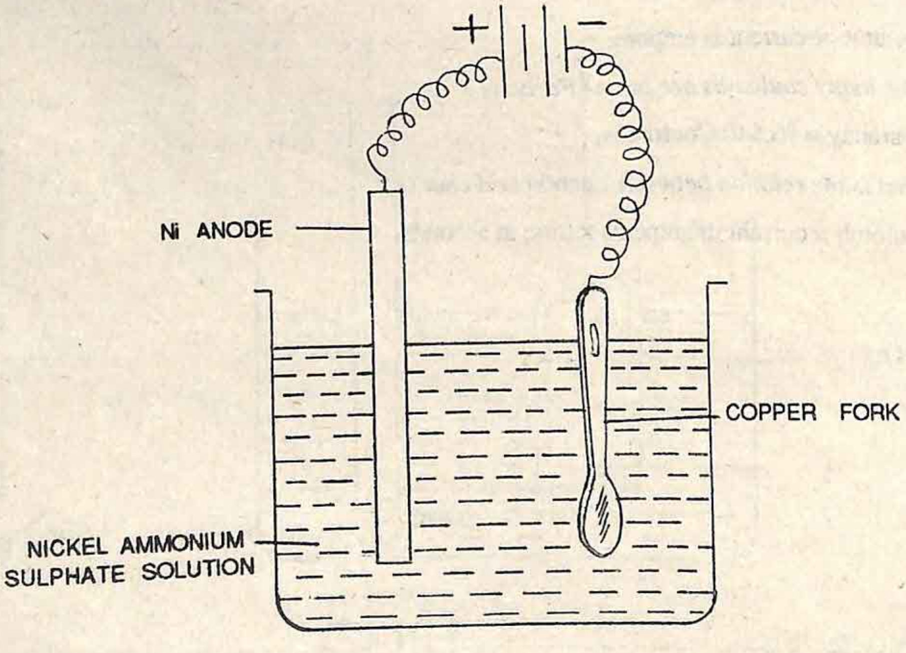


Fig. 1.10 Electroplating of Ni over Cu Fork

ORAL QUESTIONS

Q. 1. *What is electroplating ?*

Ans. Electroplating is a process by which a superior metal can be deposited over another metal by passing current.

Q. 2. *What is the use of electroplating ?*

Ans. It is used to protect metals from corrosion and for beautifying them.

Q. 3. *Which metal is used as anode ?*

Ans. Ni is used as anode (because of its oxidation potential).

Q. 4. *What are the characteristics of a good electrolyte used for electroplating ?*

Ans. The electrolyte is soluble salt of the metal. The electrolyte used in electroplating should be :

(a) highly soluble

(b) good conductor of electricity

(c) stable towards oxidation, reduction and hydrolysis

(d) cheap in cost.

Examples : Nickel ammonium sulphate is used in Nickel plating, Potassium argentocyanide is used in silver plating.

Q. 5. *Give two conditions for good deposition.*

Ans. Low temperature, high current density and high metal concentration are the conditions which favour smooth and bright deposit of a metal.

UNIT 2

MOTION, FORCE AND ENERGY

Introduction

Importance of Physics : In general, we define science as a subject of reasons 'How and Why' ? Scientists in this world go ahead with this firm belief that no event happens for without reasons. Today man has already reached Moon and is trying to reach Mars. It has all been possible due to Physics which is that branch of science in which we study about the different properties of matter and about different types of energies. We will be able to understand this branch of science more effectively with the help of the syllabus of experiments in Physics. To understand the principle of science thoroughly and to conceive it in mind for ever, the experiments play a very important role. When you do practicals you make use of your hands and mind. Here you are active participant and learning by doing. In class room you are only passive listener.

Whatever is taught to you in theory on black board that you see and listen and do not really learn practically. Physics laboratory is a place where you can enjoy while doing your experiments and relax in between your theory classes. Science is a branch of reasoning and observation. We do not believe any thing which has no reasoning along with the experimental evidence directly or indirectly. So the study of physics or any other branch of science is incomplete without experiments i.e. practical work.

General Directions to the Students

1. The laboratory is a place of performing experiments. Therefore, as soon as you come in the laboratory, start your experiment after taking the necessary apparatus required by you.

2. Ask your teacher about the experiment for the next turn and come prepared for that experiment in the laboratory.

3. Be in discipline while you are in the laboratory and do not wander here and there for nothing and do not waste your time and the time of others.

4. Bring your practical note book and practical book without fail.

5. Consult your teacher while you are in difficulty.

6. Do not write your observations directly on the practical note book. First get it checked by your teacher.

7. Get your electric circuit diagram checked before starting your electricity experiment.

8. Perform your experiment with confidence and do not make haste.

9. If any apparatus is not in use, return it immediately.

10. Write your experiment as follows:

On left page	*On right page*
(*a*) Figure (*b*) Observations (*c*) Calculations	(*a*) Date and Experiment No. (*b*) Object (*c*) Apparatus (*d*) Principle (*e*) Procedure (*f*) Result (*g*) Precautions

11. Whole experiment including graph should be neat and clean.

12. Observe all the precautions of the experiment so that the correct result may be obtained.

13. Don't manipulate your observations to get correct result.

14. Don't perform the experiment mechanically. Try to understand its principle and theory.

15. Don't take the reading less than the least count of the instrument. If the reading is less than half of the least count, note the reading of the previous mark. If it is half or more than half, note the reading of the next mark.

16. If the least count of your instrument is .01, write your reading as 15.00 even if it is 15 only. It is very important.

17. Study the question-answer given at the last of every experiment attentively. In examination such questions are asked.

18. As soon as you are allotted an experiment in the examination, you start your experiment with patience and confidence. Before the examiner comes to you, recollect your memory to answer those questions which may possibly be asked by him. This will help you in answering his questions correctly and confidently.

How to draw a graph

(1) Take independent quantity on x-axis and dependent quantity on y-axis as in Fig. (A).

(2) Select the proper scales for x and y-axis so that whole of the graph paper is used. Two scales

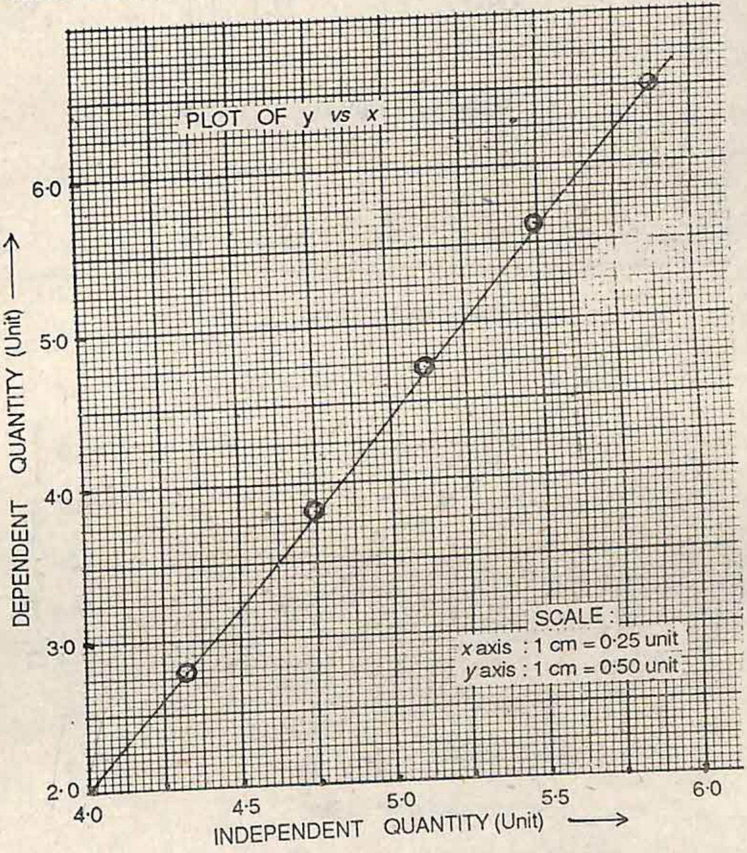


Fig. A

need not to be necessarily same. Write the scales on graph paper for x and y-axis separately.

(3) Write on the graph paper the names of the quantities to be plotted in broad letters along the x and y-axis with their units in bracket respectively.

(4) Plotting the points and joining them should be done with a hard pointed end pencil.

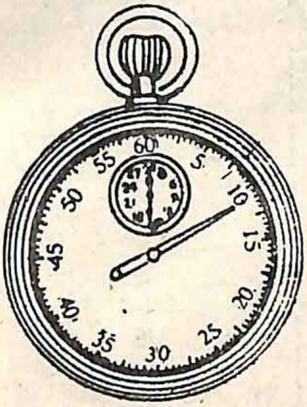
(5) Draw the graph very carefully and avoid using eraser.

(6) Join the points by free hand in such a way that maximum number of points lie on the graph. It is not necessary that all the points should lie on the graph due to experimental error. Also write the heading of the graph.

EXPERIMENT 2.1

To study the motion of a trolley in a straight line by plotting x-t graph of the data recorded.

Apparatus : A trolley, a smooth plane with a pulley, a pan, weights, an ink bottle with a stop-cock, white paper strips, stop watch and thread.



Stop watch

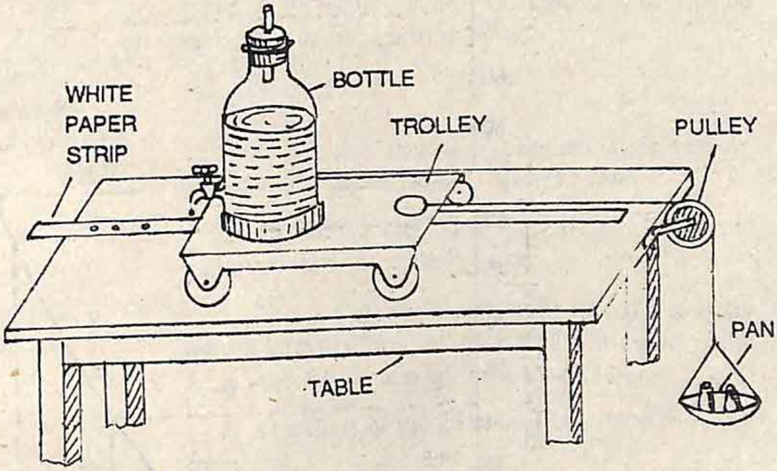


Fig. 2.1 (a) Motion in a straight line

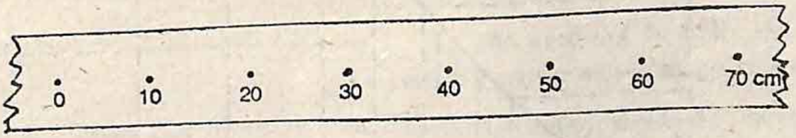


Fig. 2.1. (b) Uniform velocity

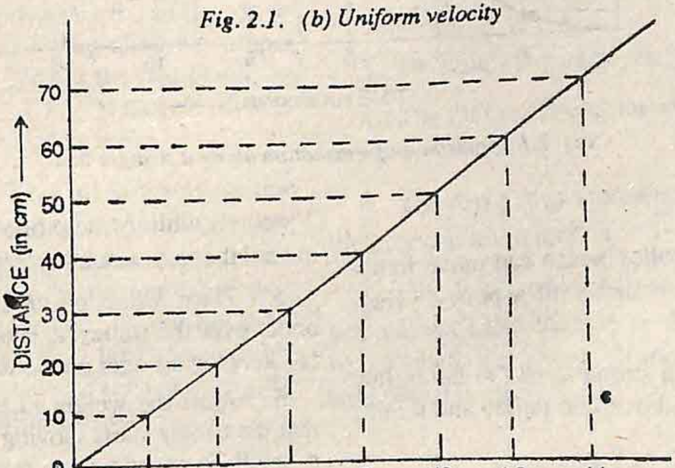


Fig. 2.1 (c) Uniform motion along a straight line

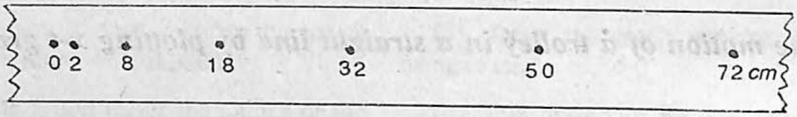


Fig. 2.1 (d) Non-uniform velocity

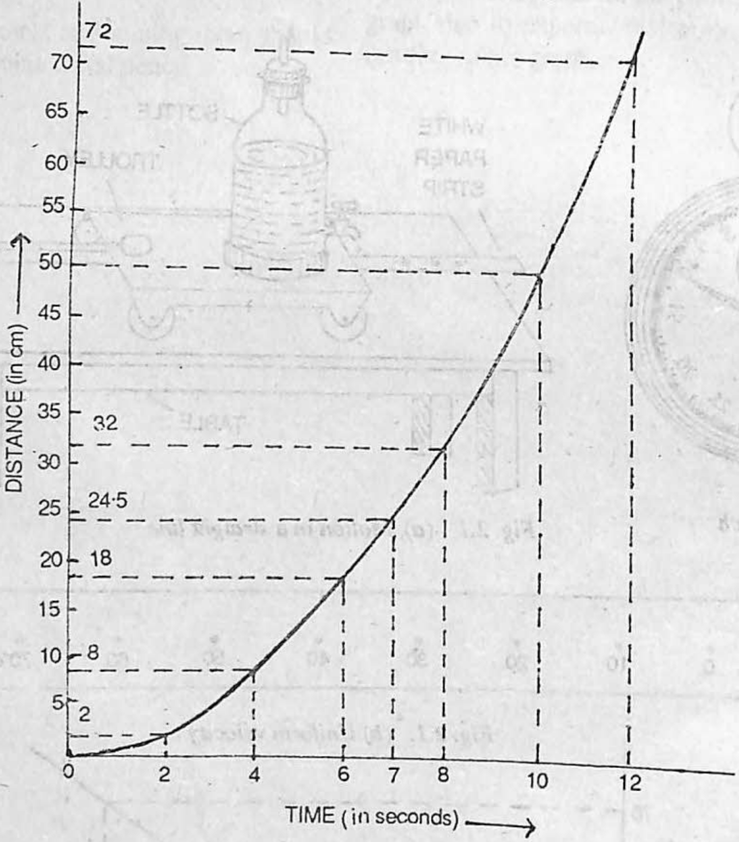


Fig. 2.1 (e) Non-uniform motion along a straight line

Procedure :

1. Take a small trolley which can move freely on a smooth table provided with a pulley. [Fig. 2.1.1 (a)]

2. Fix one end of a strong thread to the trolley and pass it its other end over the pulley and tie this end with a pan.

3. Fill a small bottle with a stop cock with ink.

4. Adjust the stop cock till each drop of ink ejects from bottle just after an interval of time, say 2 seconds with the help of stop watch. Learn how to read the stop watch correctly from your teacher.

5. Place white paper strip on table and ink bottle over the trolley as shown in the Figure 2.1.1 (a) keeping a finger on the mouth of the bottle.

6. Adjust the weight in the pan in such a way that the trolley starts moving after it is pushed with a small force and then remove immediately the finger from the mouth of the bottle.

7. Drops of ink will leave the marks on the white paper strips [Fig. 2.1.1 (b)]

8. Measure the distance of each successive drop of ink from the first drop with a scale.

9. Repeat the experiment with a fresh white paper strip and by adding some more weights so that the trolley starts to move itself.

10. Record your observations as follows:

Observations Table :

S. No.	Time in seconds (t)	Distance of successive drops from first drop (in cm)	
		Strip I	Strip II
1	0	0	0
2	2	10	2
3	4	20	8
4	6	30	18
5	8	40	32
6	10	50	50
7	12	60	72
8	14	70	—

Calculations :

1. Draw the graph between time (t) taking it on x-axis and distance (x) moved by the trolley on y-axis for each strip separately by choosing proper scales for x and y-axis. We get the two graphs as shown in the Figure 2.1.1 (c) and 2.1.1 (e). Consider the time of first drop as zero.

2. The graph in Fig 2.1.1 (c) is a straight line and speed of the trolley at any instant of time can be obtained by dividing the distance travelled by the trolley from the start by the time at that instant i.e. the slope of the straight line. In the Fig 2.1.1 (c) it is 50/10 = 5cm s^{-1} at 10s. It can be seen that it is 5 cm s^{-1} at other instants of time also. So the trolley is moving with uniform speed.

3. The graph in Fig. 2.1.1 (e) is a curve. The speed of the trolley at any instant in this case will also be obtained as in Fig. 2.1.1 (c), but this will be the average speed of the trolley up to that instant of time. In the Fig. its value is 18/6 = 3 cms^{-1} for 6 seconds, 32/8 = 4 cms^{-1} for 8 seconds. For 7 seconds it will be 24.5/7 = 3.5 cms^{-1}. Since the speed of the trolley is not constant, it is said to be moving with non-uniform speed.

Result :

1. In first case (for strip I) the trolley is moving with uniform speed and its value is 5 cms^{-1}.

2. In second case (for strip II) the trolley is moving with non-uniform speed.

3. The x-t graph is a straight line if the body moves with uniform speed and it is a curve if the body moves with non-uniform speed.

4. The slope of the distance-time graph measure the speed.

Precautions :

1. The wheels of the trolly and the surface on which it is to be moved should be smooth.

2. The trolley should be moved gently in a straight line.

3. The pulley should be frictionless.

4. The rate of flow of ink should be small (1-5 seconds) and uniform.

5. The paper strip should not be displaced after the trolley is set in motion.

6. The scales on x-axis and y-axis should be selected such that the size of the graph should not be too small or too large. It should be drawn with a hard pencil neatly.

EXERCISE

1. The position of a ball rolling down an inclined plane, at the end of each 5 seconds are given in the following table:

Time (in sec)	0	5	10	15	20	25
Distance (in cm)	0	10	40	90	160	250

Plot a distance-time graph for the motion of the ball. Indicate whether the motion is uniform or non-uniform.

2. The position of drops in an experiment of motion of trolley with time in two cases is found to be as follows:

Time (in sec)	0	4	8	12	16	20
Distance (in cm) 1st case	0	8	16	24	32	40
Distance (in cm) 2nd case	0	4	16	36	64	100

Plot a distance-time graph for the motion of the trolley in each case. Indicate whether the motion is uniform or non-uniform. How much speed will the trolley have at the end of 10 seconds in each case.

EXPERIMENT 2.2

To plot speed-time graph from a given data and calculate acceleration from it.

Procedure and Observations :

1. Let a car/scooter be moving on a straight road. The following table gives the speed of car/scooter as noted by speedometer against time in three different cases.

2. Choose the proper scale for time to plot it on x-axis. Let it be 1cm = 5 sec.

3. Similarly choose a proper scale for speed to plot it on y-axis. Let it be 1 cm = 5 kmh^{-1}.

4. Draw the graph in each case. In 1st case graph is a straight line [Fig. 2.2.1 (a)]. In 2nd case graph is a curve [Fig 2.2.1 (b)] and in 3rd case graph is again a curve [Fig 2.2.1 (c)].

Time (in sec.)	0	10	20	30	40	50
Speed (in kmh^{-1}) 1st case	0	5	10	15	20	25
Speed (in kmh^{-1}) 2nd case	10	20	30	40	40	40
Speed (in kmh^{-1}) 3rd case	15	20	30	45	65	60

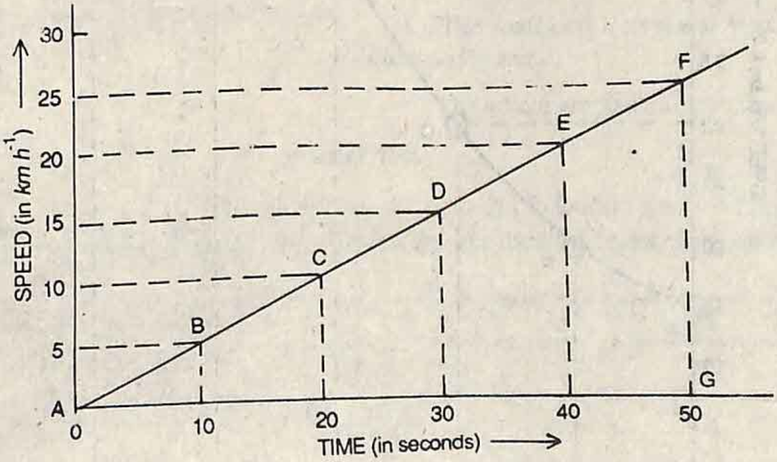


Fig. 2.2 (a)

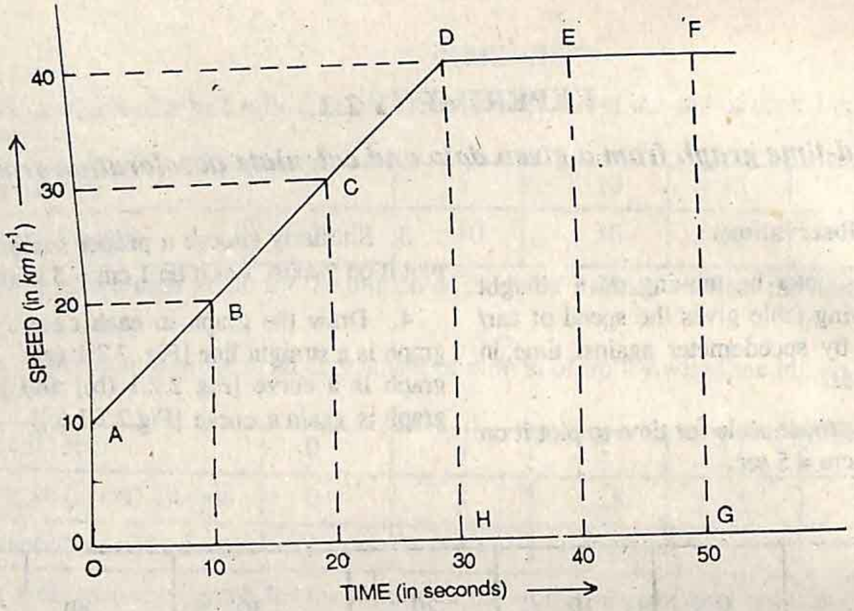


Fig. 2.2 (b)

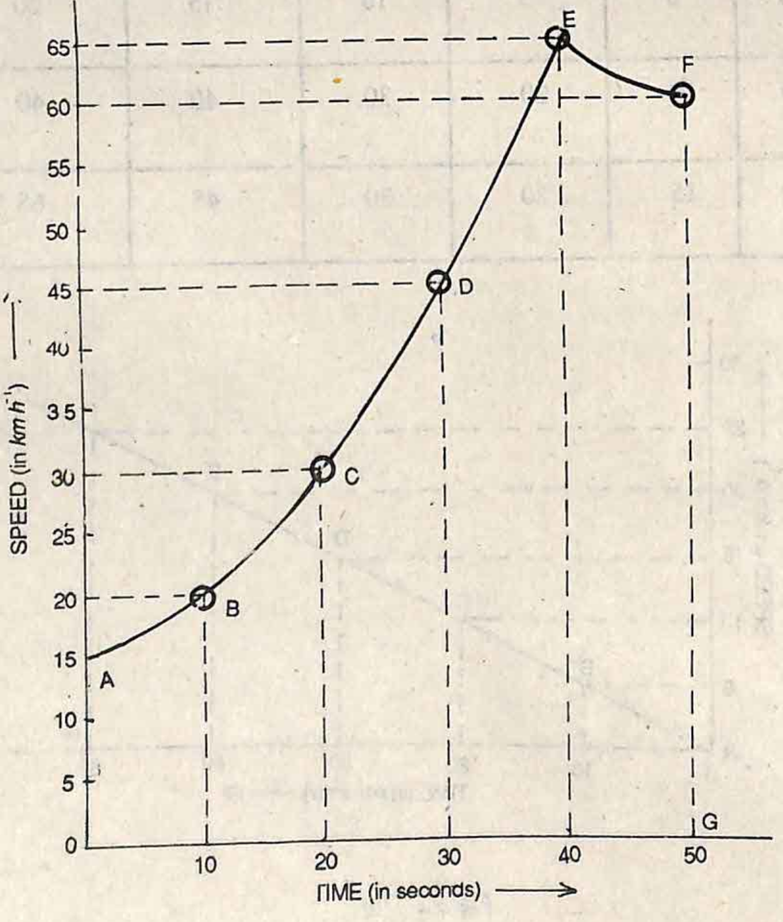


Fig. 2.2 (c)

Calculations :

1. In 1st case [Fig. 2.2.1 (a)] in each interval of time of 10 sec. the increase in speed of the car/scooter is 5 $\text{kmh}^{-1} = 5 \times \frac{5}{18}\ \text{ms}^{-1} = 1.389\ \text{ms}^{-1}$

$$\therefore \text{acceleration} = \frac{1{\cdot}389 \times 100}{10} = 13{\cdot}89\ \text{cms}^{-2}$$

∴ The car/scooter is moving with uniform acceleration.

Distance moved by car/scooter = Area of ΔAGF $= \frac{1}{2} \times 50 \times (25 \times \frac{5}{18}) = 173.6\ \text{m}$

2. In 2nd case [Fig 2.2.1 (b)], from A to D the car/scooter is moving with uniform acceleration given by

$$a = \frac{10\ \text{kmh}^{-1}}{10\ \text{s}} = \frac{5}{18}\ \text{ms}^{-2} = 0{\cdot}278\ \text{ms}^{-2}$$
$$= 27{\cdot}8\ \text{cms}^{-2}$$

From D to F the car/scooter moves with constant speed of 40 kmh^{-1}. So its accleration from D to F is zero.

Distance moved = Area of trapezium OADH + Area of rectangle DFGH

$$= \frac{1}{2}(10 + 40)\frac{5}{18} \times 30 + 40 \times \frac{5}{18} \times 20 = 430\ \text{m}$$

3. In 3rd case [Fig. 2.2.1 (c)], the change in velocity in equal interval of time are different *e.g.* the speed increases by 10km/h in 10 sec. from B to C and it decreases by 5 km/hr in 10 sec. from E to F.

Result :

1. In 1st case the car/scooter is moving with uniform acceleration of 13.89 cms^{-2}.

2. In 2nd case the car/scooter first moves with uniform acceleration of 27.8 cms^{-2} and then after attaining the speed of 40 kmh^{-1}, it moves with constant speed.

3. In 3rd case the car/scooter is moving with non-uniform acceleration.

4. The speed-time graph is a straight line for uniformly accelerated body and it is a curve for non-uniform accelerated body.

5. The area under the speed-time graph (whether straight line or curve) gives the distance moved by the body during that interval of time for which the graph is drawn.

Precautions :

1. Take a (graph) paper of good quality.

2. Always draw the graph with a hard pencil so that it can be erased easily when needed without making the paper dirty.

3. The scales on x-axis and y-axis should be selected such that the size of the graph should not be too small or too large.

4. The scales on x-axis and y-axis need not be necessarily same.

5. The whole graph should be neat and clean.

EXERCISE

1. The speedometer of a car moving on a straight road gives the following speed at regular interval of time of 5 second. Draw its speed-time graph and calculate the acceleration of the car from the graph.

Time (in sec.)	0	5	10	15	20	25
Speed (in km/h)	0	10	20	30	40	50

Calculate also the distance covered by car in 25 seconds.

2. The speed of a scooter as registered by its speedometer at different instant of time in two different journeys is as follows :

Time (in sec)	0	2	4	6	8	10
Speed (in kmh^{-1}) 1st journey	0	5	10	15	20	25
Speed (in kmh^{-1}) 2nd journey	20	24	28	32	36	40

Draw speed-time graph in each case. In which journey the scooter is accelerating faster ? Calculate the distance covered by scooter in 10 seconds in each case.

3. A bus has to travel from Red Fort to Delhi Gate straight by Daryaganj. The speed of the bus as registered by its speedometer at different instant of time is as follows :

Time (in sec)	0	10	20	30	40	50	60	70	80	90	100
Speed (in kmh^{-1})	0	15	30	45	60	10	15	25	40	50	0

Draw the speed-time graph from the above data. Does the bus moves with uniform acceleration or non-uniform acceleration.

4. The speedometer of a car registers the following speed at interval of time 1s. Draw speed time graph of journey.

Time (in sec)	1	2	3	4	5	6	7	8
Speed(in ms^{-1})	4	8	12	16	20	15	10	5

Calculate the distance travelled by the car in 8 sec.

ORAL QUESTIONS

Q. 1. *Define speed.*

Ans. It is the rate of change of distance of a body with time.

Q. 2. *What is its unit ?*

Ans. Its S.I. unit is ms^{-1}(metre per sec.) but its practical unit is km h^{-1} (kilometre per hour) but it is also measured in cms^{-1}, m/min, etc.

1 km h^{-1} $=\frac{5}{18}$ ms^{-1}

Q. 3. *Define velocity.*

Ans. It is the rate of change of displacement of a body with time.

Q. 4. *Distinguish between speed and velocity.*

Ans. The speed is a scaler quantity i.e. it has only magnitude while velocity is a vector quantity i.e. it has magnitude and as well as direction. So speed is the magnitude of the velocity whereas the velocity of a body is its speed in a particular direction.

Q. 5. *How can you measure the speed of a body from its distance-time graph ?*

Ans. The slope of the graph measures the speed of the body.

Q. 6. *What do you mean by uniform speed ?*

Ans. If a body travels equal distances in equal interval of times however small, it is said to be moving with uniform speed.

Q. 7. *What type of distance-time graph do you expect for a body moving with (a) uniform speed (b) non uniform speed ?*

Ans. (*a*) Straight line

(*b*) Curve

Q. 8. *Define acceleration ?*

Ans. It is defined as the rate of change of velocity of a body with time.

Q. 9. *What is the unit of acceleration ?*

Ans. S.I. Unit of acceleration is ms^{-2}.

Q. 10. *What is the shape of speed-time graph if the body is moving with (a) uniform velocity (b) uniform acceleration (c) nonuniform acceleration ?*

Ans. (*a*) A straight line parellel to the time axis

(*b*) A straight line inclined to the time axis

(*c*) A curve

Q. 11. *What do you mean by retardation ?*

Ans. The negative acceleration is called retardation i.e. it is the rate of decrease of velocity.

Q. 12. *Is it possible for a body to be accelerated, if its speed is constant.*

Ans. Yes, it is possible if the body is moving in a circular path with the constant speed.

□ □

EXPERIMENT 2.3

To demonstrate equal and opposite forces.

Apparatus : Two spring balances and a rigid block fixed on the table and having a hook.

Procedure :

1. Arrange the two springs as shown in the figure.

2. Pull the spring in your hand. Take the reading of both the springs.

3. It is found they are same and in opposite direction.

4. Now pull the spring with little more force you will find again the readings of two springs as same and in opposite direction.

5. So the two forces are always equal and opposite.

Result : To every action there is an equal and opposite reaction.

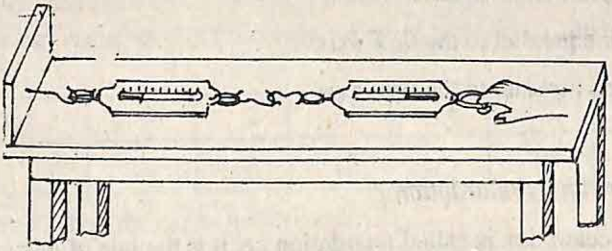


Fig : 2.3.

EXPERIMENT 2.4

To calculate the work done in lifting a body.

Apparatus : A body (say a heavy stone), a spring balance (0-1000g), a metre scale and a piece of the thread.

Procedure :

1. Tie the thread around the stone so that the hook of the spring may hold the thread and the stone can be lifted.

2. Make a scale in vertical direction on the wall of your Physics laboratory upto a height of 2 metres. Lift the stone by spring balance from the ground upto the certain mark on the scale exactly in the vertical direction.

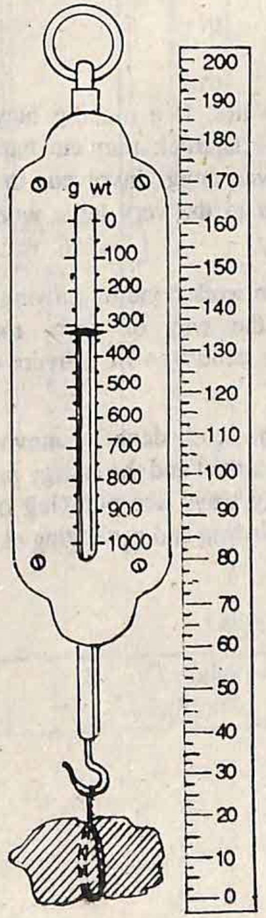


Fig : 2.4

The work done in lifting the weight will be calculated by

$w = m\,g\,h$

Where m = Reading of the spring balancing in g.

g = Acceleration due to gravity = 980 cms^{-2}

h = Reading of the mark on the scale in cm.

3. Take different value of 'm' & 'h' & calculate the work done in each case.

Observations : Least count of spring balance = ... g.

Zero error of spring balance = ... g.

$g = 980\ cms^{-2}$

For lifting the body:

S. No.	*Mass of the body (m) (in g)*	*Height of the mark (h) (in cm)*	*Work done (mgh) (in ergs)*
1			
2			
3			
4			
5			

Result : The work done in lifting the body in different cases is different.

Precautions :

1. Note the zero error & least count of spring balance carefully.

2. The pointer of the spring balance should move freely.

3. The body should be lifted exactly in the vertical direction by drawing a vertical line on the wall

4. Measure the height of the mark on the scale accurately.

EXPERIMENT 2.5

To demonstrate the work done by a moving body.

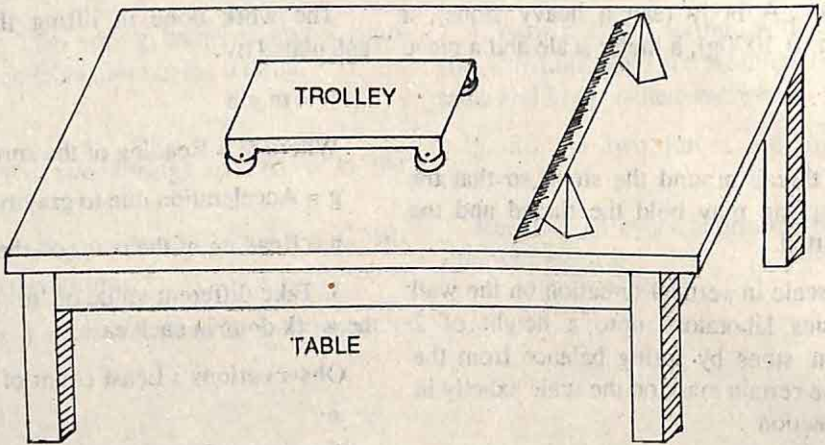


Fig. 2.5

Apparatus : A trolley, a half metre rod and 2 prisms.

Procedure :

1. Arrange the half metre rod on the two prisms as shown in the figure.

2. Move the trolley. When it strikes the half metre rod, the rod is thrown away.

3. It means a work is done by a moving body (trolley).

Conclusion :

1. Not only work in done by moving trolley in above demonstration, but we observe it everywhere in our daily life. If a moving bicycle, rickshaw, scooter, car, bus, truck, train etc. happen to meet an accident, everything involved in accident get smashed due to the very large work done by the moving body.

2. It is the work done by moving water that the turbine in the way of water rotates and the electricity is generated in a hydro-electric power station.

3. It is the work done by moving air that the wind mill is turned and the energy produced can be used in many ways like pumping out water from the earth, grinding and generating electricity etc.

EXPERIMENT 2.6

To demonstrate the work done by a compressed spring.

Apparatus : Three standard weights each of half kg, helical spring and a metre scale fitted on a stand as shown in the figure.

Procedure :

1. Put three half kg weights on the top of the experimental arrangement as shown in the figure :

2. Note the position of the platform 'P' on the vertical scale.

3. Now remove one weight from the platform, the spring will move up. Note the new position of the platform.

4. Similarly remove second and third weight from platform and note its new position every time.

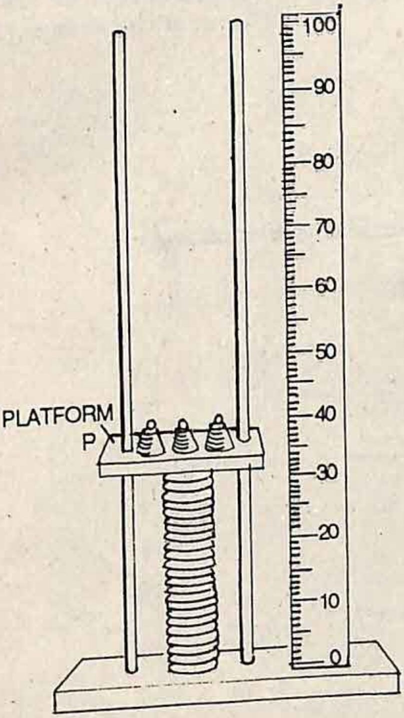


Fig : 2.6 (a)

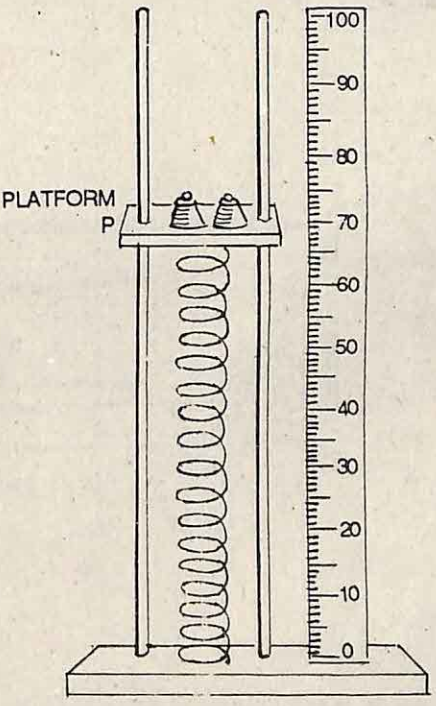


Fig : 2.6 (b)

Observations :

Least count of metre scale = ...cm

S. No.	*No. of weights on platform*	*Reading of the platform (R) in cm*	*Distance moved (s) in cm*
1	3	R_1	
2	2	R_2	$(R_2 - R_1)$
3	1	R_3	$(R_3 - R_2)$
4	0	R_4	$(R_4 - R_3)$

Mean distance moved (S) = ...cm = ...m

Calculations :

Work done,

$W = F \times S$

$= mg \times S$

Now $m = 0{\cdot}5\text{kg}$, $g = 9{\cdot}8\text{ms}^{-2}$ & $S = ...\text{m}$

$\therefore$ W = ...

= .....Joule

Result :

The work done by a compressed spring = ...J

Precautions :

1. Least count of the metre scale should be noted.

2. Readings on the scale should be taken only when the platform becomes stationary.

3. Weight should be removed from platform gently.

4. The platform should be free to move by the force of expanding spring.

EXPERIMENT 2.7

To demonstrate propagation of waves in a stretched rope.

Apparatus: A rope stretched between two nails on a table.

Procedure :

1. Stretch a rope between two nails fixed on a table as shown in the Fig. 2.7.

2. Make the rope to oscillate by displacing it at one end perpendicular to its length.

3. You will find the transverse waves travelling along the rope as shown in second figure.

Conclusion :

The propagation of transverse waves can be shown on a stretched rope.

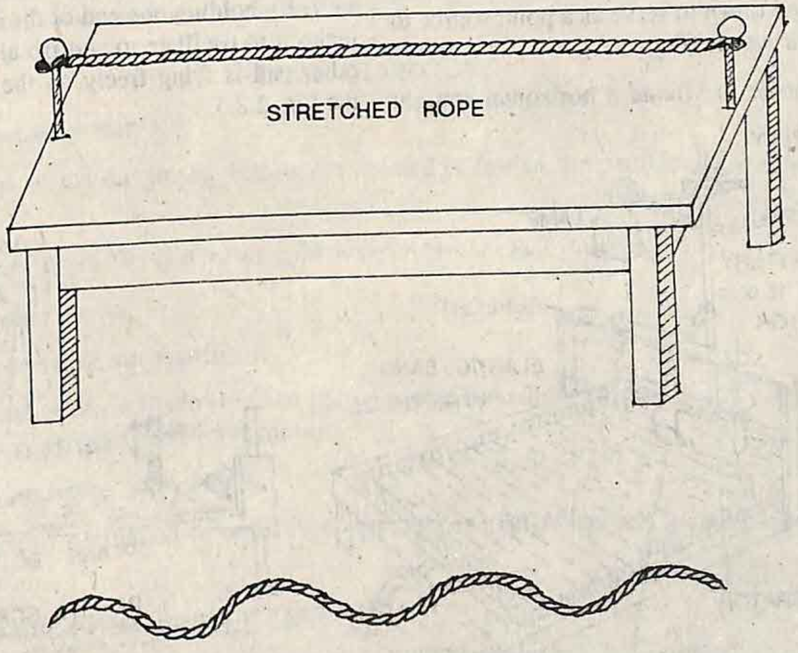


Fig. 2.7. Transverse waves travelling on rope

EXPERIMENT 2.8

To demonstrate propagation of waves through (a) water surface (b) slinky.

Apparatus :

Ripple tank and slinky.

Procedure :

1. A ripple tank consists of a shallow tank with a glass base (Fig. 2.8.1) having a light above it which projects any water waves produced in the tank on a white drawing sheet fixed on the table lying under the tank (Fig. 2.8.2).

2. Fill the tray with water to a depth of about 2 cm.

3. Make a small variable speed motor to vibrate a thin rod up and down to serve as a point source to produce circular waves (Fig 2.8.3).

4. Adjust motor to vibrate a horizontal straight stick so as to produce plane waves (Fig 2.8.4).

5. In both the Figs. 2.8.3 & 2.8.4 alternate bright and dark lines are seen moving forward. The motion of the bright and dark lines is correspond to the motion of crests and troughs respectively in the propagation of transverse waves.

Propagation of waves in slinky

6. Arrange a slinky with its length parallel to the length of the table. Slinky is a long elastic spring with heavy turns very close to each other in normal position.

7. By holding one end of the spring in your hand make it to oscillate to and fro along its length. The other end is lying freely on the table as shown in the Fig. 2.8.5.

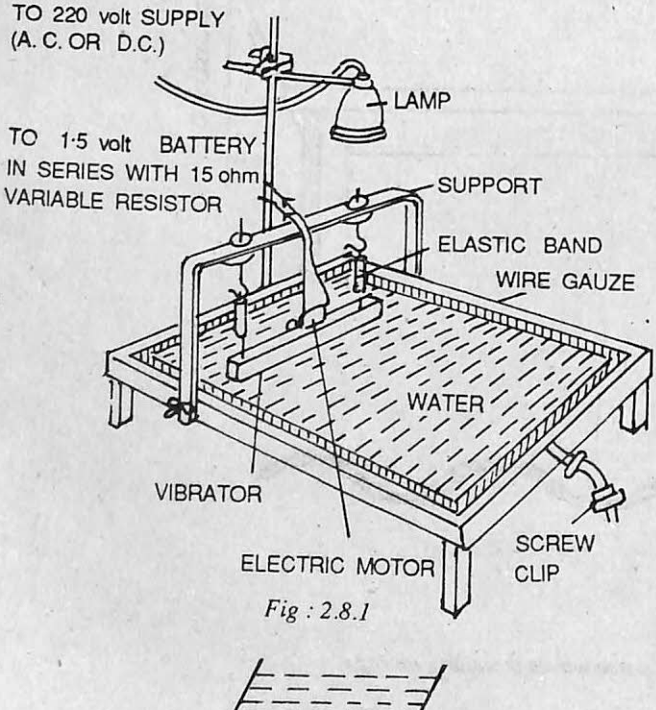


Fig : 2.8.1

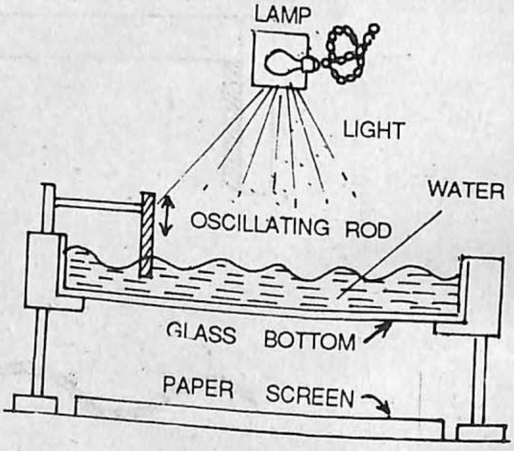


Fig : 2.8.2

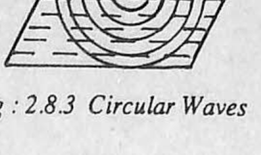


Fig : 2.8.3 Circular Waves

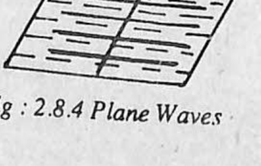


Fig : 2.8.4 Plane Waves

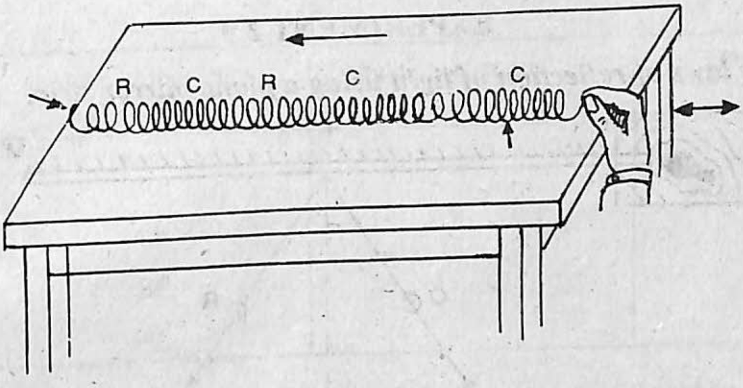


Fig : 2.8.5

8. You will find in the slinky a series of alternate compressions (C) and rarefactions (R) which appear to move along the length of the slinky. It represents the propagation of longitudinal waves in the slinky.

ORAL QUESTIONS

Q. 1. *What is a wave motion ?*

Ans. The motion of the imaginary disturbance created in few of the particles of the medium is called wave motion.

Q. 2. *What are the requisties of a medium for wave motion to take place ?*

Ans. Elasticity and inertia.

Q. 3. *What is transverse wave motion ?*

Ans. If the direction of oscillations of the particles of the medium is at right angle to the direction of wave motion, it is called transverse wave motion.

Q. 4. *What is longitudinal wave motion ?*

Ans. If direction of oscillation of particles of medium is along (parallel) to wave motion, it is called longitudinal waves.

Q. 5. *In what medium these waves are possible ?*

Ans. The longitudinal waves are possible in all the three media i.e. solid, liquid and gas. The transverse waves are possible only in solids. But these waves are also possible on the free surface of liquids due to the property of surface tension.

EXPERIMENT 2.9

To verify tne laws of reflection of light using a plane mirror strip.

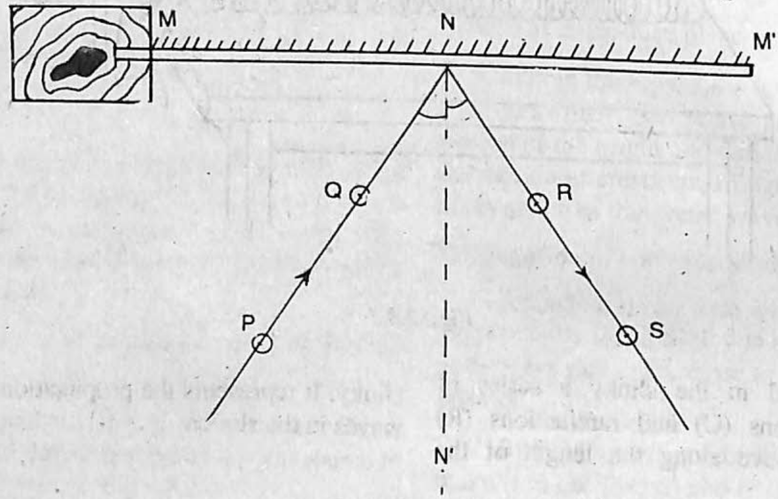


Fig. 2.9

Apparatus : Drawing board, sheet of paper, drawing pins, plane mirror strip, wooden block with a groove to hold the mirror strip, pins, half-metre rod, pencil and protractor.

Procedure :

1. Fix the sheet of paper on the wooden board with the help of drawing pins.

2. Divide the sheet in four equal rectangular parts.

3. Draw a straight line MM' in the middle of each part of the sheet. Draw a normal NN' on each line at its middle.

4. Draw a straight line PQ making an angle of incidence PNN' equal to 30⁰ in the first part. In other three parts, take this angle of incidence equal to 40⁰, 50⁰ and 60⁰.

5. Place the mirror strip such that its front side edge is touching the line MM' and is parallel to it. Fix two pins at P and Q about 2 cm away from each other on the straight line PQ.

6. Seeing the mirror strip from the other side, fix other two pins as R and S such that all the four pins appear to be in the same straight line.

7. Remove the pins at P and Q, mirror strip and then pins at R and S after marking their positions. Draw the straight line RS and measure the angle of reflection N'NS.

8. Repeat the experiment with angle of incidence 40⁰, 50⁰ and 60⁰ in remaining three parts of the sheet. In each case measure the angle of reflection and fill up your observations in the following table.

9. In each case reflected ray is in the same plane as the incident ray.

Result :

Within the limits of experimental error, the angle of incidence is equal to the angle of reflection and the incident ray, the reflected ray and the normal are all in the same plane, hence laws of reflections are verified.

Precautions :

1. Place the mirror with its front side edge touching the front straight line and its plane vertical.

2. The pins should be vertical and having a pointed tip.

Observations :

S. No.	Angle of incidence $\angle i$ ($\angle$PNN$'$)	angle of reflection $\angle r$ ($\angle$SNN$'$)	Difference ($\angle i \sim \angle r$)
1.	30^0		
2.	40^0		
3.	50^0		
4.	60^0		

3. Not only heads but the feet of the pins should also be in the same straight line.

4. The mirror should be thin and well polished and its polish should be uniform.

5. Direction of rays should be shown by arrow heads.

6. A hard and fine pointed end pencil should be used.

ORAL QUESTIONS

(See Oral Questions of Experiment 2.10)

EXPERIMENT 2.10

To show that the image formed in a plane mirror is as far behind the mirror as the object is in front of it and the line joining the image and the object is normal to the mirror.

Apparatus : Drawing board, sheet of paper, drawing pins, plane mirror strip, wooden block with a groove to hold the mirror strip, pins, half-metre rod, pencil and protractor.

Procedure :

1. Fix the sheet of paper on the wooden board with the help of drawing pins.

2. Divide the sheet in four equal rectangular parts.

3. Draw a straight line MM′ in the middle of the sheet in one part and place the mirror with its front side edge on the line MM' vertically.

4. Fix a pin O in front of the mirror. Look in the mirror along some direction PQ on the left for the image of O and fix two pins P and Q in such a way that the feet of all the three pins appear to be in a line.

5. Similarly, looking into the direction RS on the right, fix other two pins such that the feet of pins R, S and the foot of the image of O are in a line.

6. Remove the pins after marking their positions.

7. Produce PQ and RS backward to meet at I. Then I is the virtual image of O.

8. Join OI cutting the mirror at N.

9. Measure the distances ON and NI and angle ∠ONM.

10. Repeat the experiment in other parts of the sheet by taking O at different distance from the mirror.

Result : This is verified that the image formed in the mirror is as far behind the mirror as the object is in front of it and the line joining the image and the object is normal to the mirror.

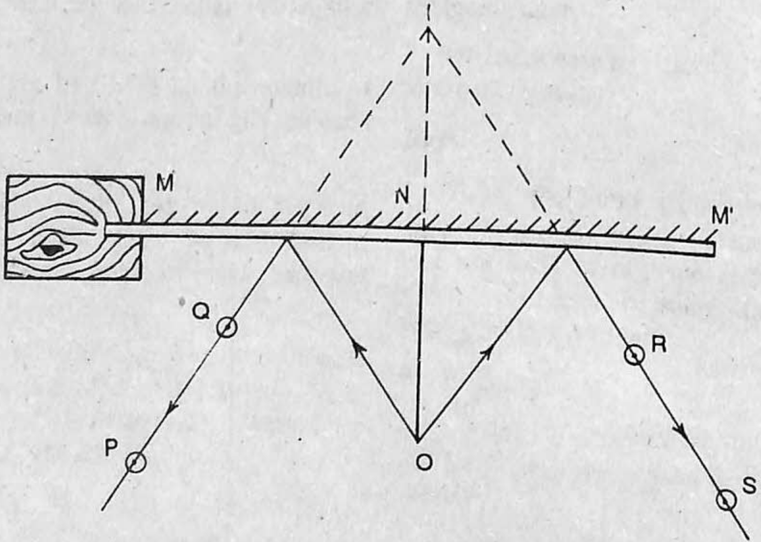


Fig. 2.10

Observations :

S. No.	*The distance from the plane mirror*		*Difference*	*∠ONM*
	of the object (ON) in cm	*of the image (IN) in cm*		
1.				
2.				
3.				
4.				

Precautions :

1. Place the mirror with its front side edge touching the straight line and its plane vertical.

2. The pins should be vertical and see that the feet of the pins are in the same straight line.

3. The mirror should be thin and its polish should be uniform.

4. Direction of rays should be shown by arrow heads.

5. A hard and fine pointed end pencil should be used.

ORAL QUESTIONS

Q. 1. *What do you understand by reflection ?*

Ans. Reflection of light is the phenomenon in which a ray of light travelling in a medium is turned back into the same medium after striking on a smooth polished surface.

Q. 2. *What are the laws of reflection ?*

Ans. There are two laws of reflection :

1. The incident ray, the reflected ray and the normal at the point of incidence lie in the same plane.

2. The angle of incidence is equal to the angle of reflection.

Q. 3. *What are the properties of the image formed by plane mirror ?*

Ans. 1. The image is erect and virtual.

2. The image suffers lateral inversion *i.e.*, the right of the image appears to be left in the image and *vice-versa*.

3. The image is formed as far behind the mirror as the object is in front of it.

Q. 4. *Does reflection take place from front surface or back surface ?*

Ans. From front shining surface.

Q. 5. *Why should we use thin mirror ?*

Ans. If the mirror is thick, some reflection will also take place at the back surface and the incident ray and reflected ray when produced will not meet at the front surface but somewhere in fromt of it. Hence the image is not distinct.

Q. 6. *Give an example of use of plane mirror from your daily life.*

Ans. The mirror, which we use at home to dress up ourselves, is a plane mirror.

EXPERIMENT 2.11

To find the change in the angle of reflection when the mirror is rotated through a given angle.

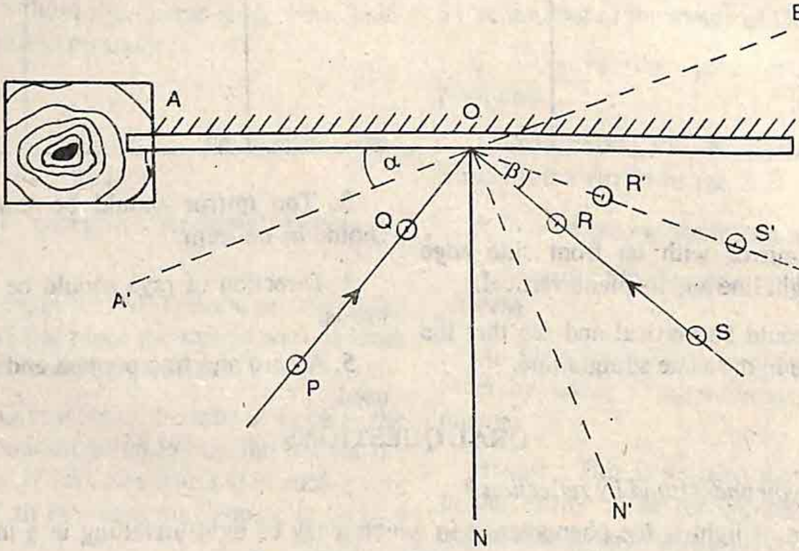


Fig. 2.11

Apparatus : Plane mirror strip with a holder, a drawing board, drawing pins and alpins.

Procedure :

1. Fix the sheet of paper on the drawing board with the help of drawing pins.

2. Divide the sheet in four equal rectangular parts.

3. Draw two straight lines AB and A'B' making an angle α (say 10°) with each other in the middle of the one part of the sheet. Draw the normals ON' and ON′ on the line AB and A'B' respectively

4. Draw a straight line PQ making an angle of incidence (say 40°) with the normal ON.

5. Place the mirror strip such that its front side edge is touching the line AB. Fix two pins at P and Q about 2 cm. away from each other on the straight line PQ.

6. Seeing the mirror strip from other sides fix other two pins at R and S such that all the four pins appear to be in the same straight line.

7. Rotate the mirror strip from the position AB to A'B' by an angle α. Without changing the positions of the pins at P and Q, change the positions of the pins from R, S to R',S' such that all the four pins again appear to be in the same straight line.

8. Remove the mirror strip and all the pins after marking their positions. Measure the angle β between the straight line RS and R'S'.

Observations :

Angle of incidence=.....

S. No.	*Angle of rotation of mirror* (α)	2α	*Angle of rotation of reflected ray* (β)	*Difference* ($2\alpha \sim \beta$)
1.				
2.				
3.				
4.				

9. Repeat the experiment in rest of the three parts by changing the value of angle *a* (say 12°, 14°, 16°). Keep the angle of incidence constant.

Result : Within the limits of experimental error, angle of rotation of reflected ray is twice the angle of rotation of mirror.

Precautions :

1. Place the mirror with its front side edge touching the straight line and its plane vertical.

2. The pins should be vertical and see that the feet of the pins are in the same straight line.

3. The mirror should be thin and its polish should be uniform.

4. Directon of rays should be shown by arrow heads.

5. A hard and fine pointed end pencil should be used.

ORAL QUESTIONS

(See Oral Questions of Experiment 2.10)

EXPERIMENT 2.12

To set up two plane mirrors at right angles to each other and study the number of images formed by this combination and to locate the central image by method of pins and to explain its formation.

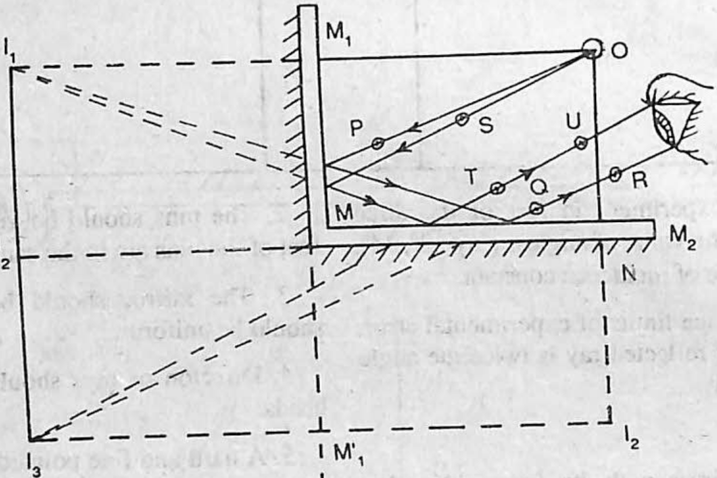


Fig. 2.12

Apparatus : Drawing board, sheet of paper, two plane mirror, strips with holders, drawing pins, alpins, half metre rod and pencil.

Procedure :

1. Fix the sheet of paper on the wooden board with the help of drawing pins.

2. Draw two straight lines MM_1 & MM_2 at right angles to each other. Place the two mirror strips with their front edges on the lines.

3. Draw two straight lines OP and OS on mirror MM_1 as shown in the figure.

4. Fix two pins first at O and P. Looking into the mirror MM_2, fix other two pins at Q and R such that these two pins and the images of pins at O and P are in the same straight line. Remove the pins from Q and R. Join R and Q and produce it up to I_3.

5. Remove the pin from P and fix at S. Looking into the mirror MM_2, fix other two pins at T and U such that these two pins and images of pins at O and S all are in the same straight line.

6. Remove the pins from O, S, T and U. Join U and T and produce the straight line up to I_3.

7. I_3 is the location of the final image of pin at O by multiple reflection of light from mirrors MM_1 and MM_2.

8. Make a rectangle $OI_1I_3I_2$ with sides $OI_1 = 2OM_1$ and $OI_2 = 2\,ON$. The final image I_3 is at the other end of the diagonal OI_3.

Result :

I_3 is the location of the final image of the pin at O. It is formed by the multiple reflection of light by the two mirrors.

Precautions :

1. Place the mirror with its front side edge touching the straight line and its plane vertical.

2. The pins should be vertical and see that the feet of the pins are in the same straight line.

3. The mirror should be thin and its polsih should be uniform.

4. Direction of rays should be shown by arrow heads.

5. A hard and fine pointed end pencil should be used.

ORAL QUESTIONS

(See Oral Questions of Experiment 2.10)

EXPERIMENT 2.13

To trace the path of rays through a glass slab and to determine the refractive index of glass.

Apparatus : Drawing board, drawing paper, drawing pins, glass slab and alpins.

Procedure :

1. Fix the drawing paper on the drawing board with the help of drawing pins. Divide it into four equal parts with the help of a pencil and a scale.

2. Place the glass slab in the middle of one part of the paper and trace its boundary ABCD.

3. Remove the glass slab and draw a perpendicular NON$_1$ at O, on AB. Draw a straight line OP making an angle of incidence equal to 30° with NO

4. Place the glass slab in its position.

5. Fix two pins at P and Q about 2 cm. away from each other on the straight line PQ.

6. Seeing the glass slab from other side CD, fix two other alpins at R and S such that all the four alpins appear to be in the same straight line.

7. Remove the pins at P and Q, glass slab and then pins at R and S after marking their positions.

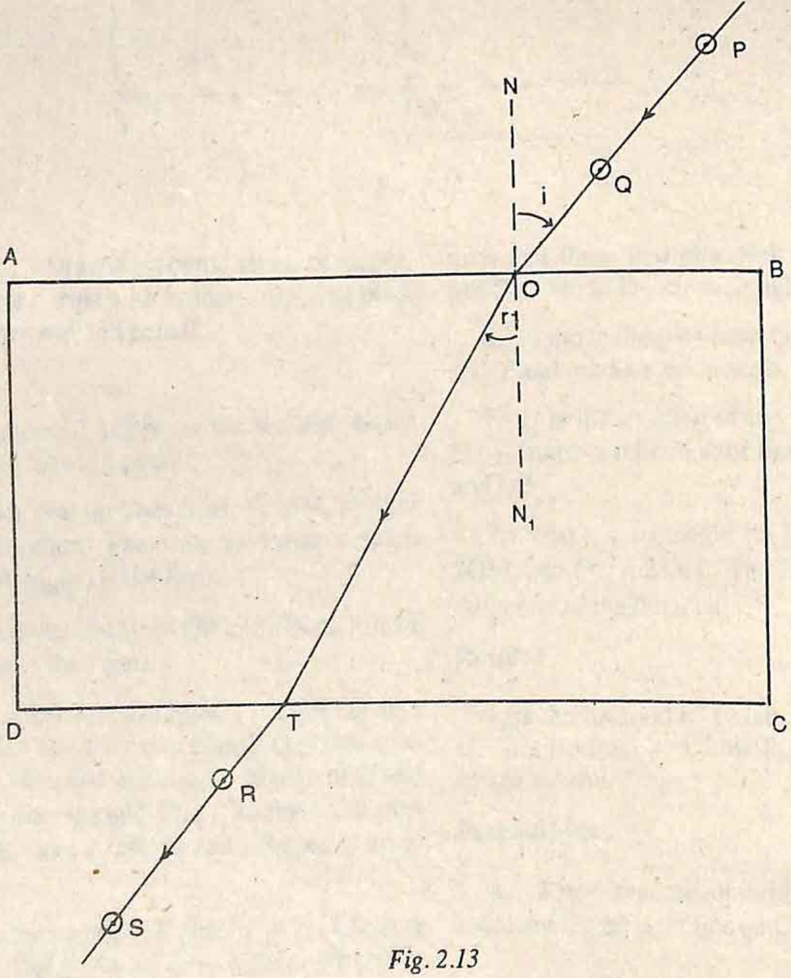


Fig. 2.13

Observations :

S. No.	*Angle of incidence (i)*	*Angle of refraction (r)*	*Sin (i)*	*Sin (r)*	$\mu = \frac{\sin (i)}{\sin (r)}$
1. 2. 3. 4.	30^0 40^0 50^0 60^0				
			Mean μ = ...		

8. Join the points R and S by a line which cuts the line CD at T. Join O and T.

9. Measure the angle of refraction N_1OT.

10. Repeat the experiment with angle of incidence 40^0, 50^0 and 60^0.

Result :

1. When ray of light passes from rare medium to denser medium, it bends towards the normal.

2. On increasing the angle of incidence, angle of refraction increases.

3. Refractive Index of glass = ...

Precautions :

1. Pins should be fixed exactly vertical.

2. The difference of angle of incidence should not be less than 5°.

3. The direction of rays should be marked by arrows.

4. Not only the heads but the feet of the pins should also be in the same straight line.

5. Pins should not be fixed by hammering them by glass slab. They should be simply pressed by the thumb. For this, the tips of the pins should be well pointed.

ORAL QUESTIONS

Q. 1. *What do you understand by refraction of light ?*

Ans. When a ray of light passes from one homogeneous medium to another homogeneous medium of different density, it diverts its path. This phenomenon is known as refraction of light.

Q. 2. *What are the laws of refraction ?*

Ans. There are two laws of refraction which state—

1. The incident ray, the refracted ray and the normal to the surface of separation at the point of incidence lie in the same plane.

2. The ratio of the sin of the angle of incidence to the sin of the angle of refraction is a constant.

Q. 3. *What do you understand by refractive index of a medium ?*

Ans. The ratio of the sin of the angle of incidence to the sin of the angle of refraction is a constant. This constant is called the refractive index of the second medium with respect to the first.

Q. 4. *What is the value of refractive index of glass, water and turpentine ?*

Ans. The value of refractive index is 1.517 for crown glass, 1.649 for flint glass, 1.333 for water and 1.470 for turpentine.

Q. 5. *How can you define refractive index of a substance in terms of velocity of light ?*

Ans. Refractive index of a substance may also be defined as the ratio of velocity of light in air to that in the substance.

EXPERIMENT 2.14

To trace the path of the incident ray, the refracted ray and the emergent ray through a rectangular glass slab and to check that the incident and the emergent rays are parallel to each other.

Apparatus : Glass slab, drawing board, drawing pins and alpins.

Procedure :

1. Fix the sheet of the paper on the drawing board with the help of drawing pins. Divide it into four equal parts with the help of pencil and a scale.

2. Place the glass slab in the middle of one part of the paper and trace its boundary ABCD.

3. Remove the glass slab and draw a perpendicular MEM_1 at E. Draw a straight line PQ making an angle of incidence of 30° with the normal EM.

4. Place the glass slab in its position.

5. Fix two pins at P and Q about 2 cm. away from each other, seeing the glass slab from the other side CD fix other two pins at R and S such that all the four pins appear to be in the same straight line.

6. Remove the glass slab and all the four pins after marking their positions. Join R and S and produce it so that it cuts the straight line CD at F. Produce the straight line PQE up to T. It will be parallel to the emergent ray RS.

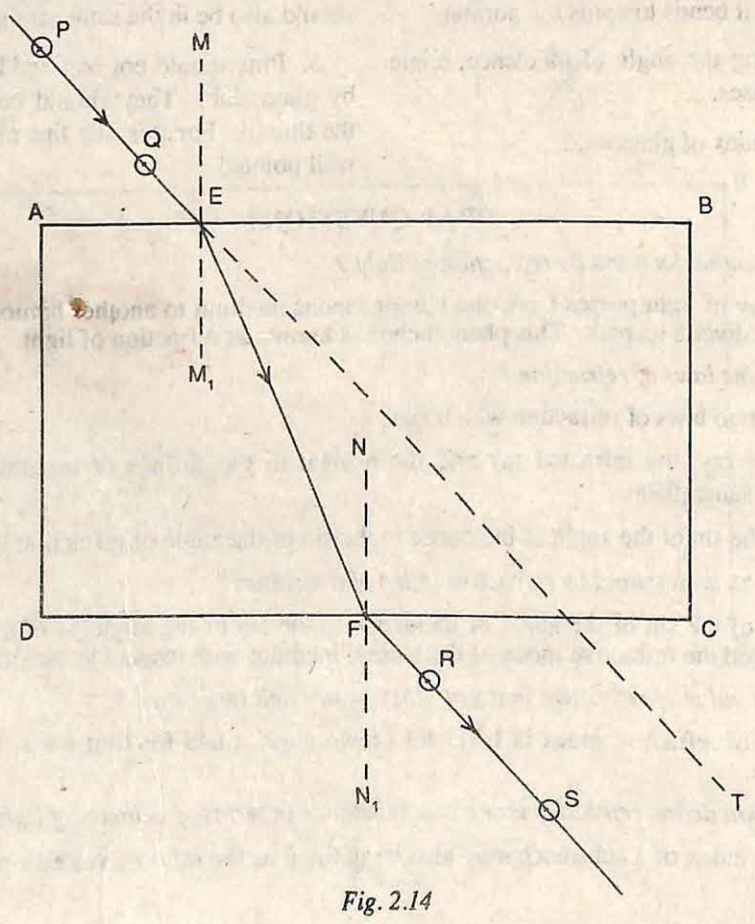


Fig. 2.14

Observations :

S. No.	*angle of incidence (i)*	*angle of emergent (e)*	*Difference (i ~ e)*
1.	30^0		
2.	40^0		
3.	50^0		
4.	60^0		

7. Measure the angle of emergent SFN_1. You will find that angle of emergent is equal to the angle of incidence.

8. Repeat the experiment in rest of the part of the paper with angle of incidence 40^0, 50^0 and 60^0.

Result : Within the limit of experimental error, the angle of emergent is equal to the angle of incidence i.e. the emergent ray is always parallel to the incident ray in a ractangular glass slab.

Precautions :

1. Pins should be fixed exactly vertical.

2. The difference of angle of incidence should not be less than 5^0.

3. The direction of rays should be marked by arrows.

4. Not only the heads but the feet of the pins should also be in the same straight line.

5. Pins should not be fixed by hammering them by glass slab. They should be simply pressed by the thumb. For this, the tips of the pins should be well pointed.

ORAL QUESTIONS

(See Oral Questions of Experiment 2.13)

EXPERIMENT 2.15

To trace the path of the incident ray, the refracted ray and the emergent ray through a rectangular glass slab in different positions and to show that the lateral shift of the emergent ray is proportional to the thickness of the slab for a given angle of incidence.

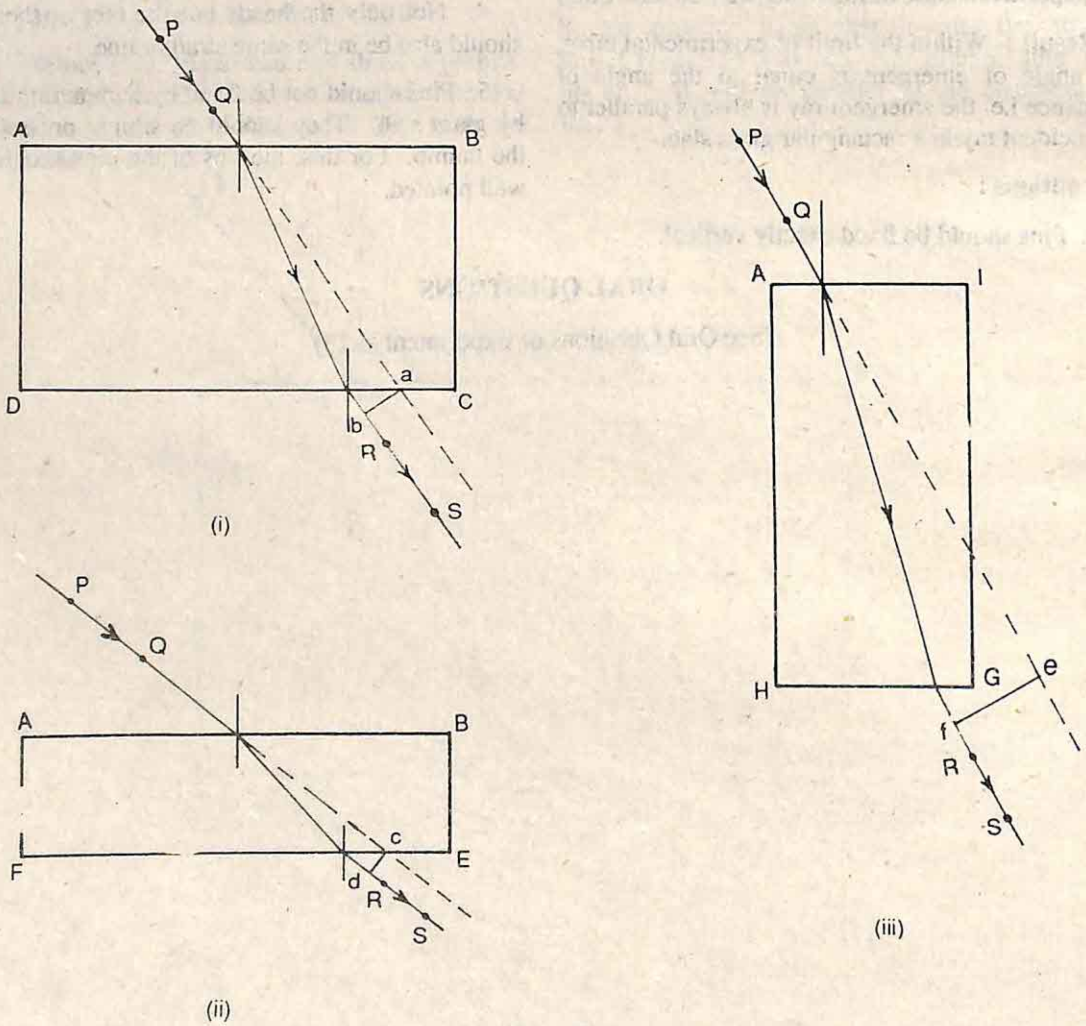
Apparatus : Glass slab, drawing board, drawing pins and alpins.

Procedure :

1. First place the glass slab in ABCD position such that its length-breadth surface is in contact with the paper.

2. Fix two pins P and Q about 2 cm. apart from each other on straight line PQ. Seeing the glass slab from other side, fix two other alpins at R and S such all the four pins appear to be in the same straight line.

3. Repeat the experiment by placing the glass slab in ABEF and AIGH positions such that its



(i)

(ii)

(iii)

Fig. 2.15

Observations :

S. No.	Thickness of the slab (x) in cm.	Displacement (d) in cm.	$\frac{x}{d}$
1.	AD =	ab = ...	
2.	AF =	cd = ...	
3	AH =	ef = ...	

length-height and breadth-height surfaces respectively are touching the paper. Keeping the angle of incidence the same as in first case.

4. Produce the line PQ and draw the emergent rays RS for the three positions of glass slab.

5. Measure the displacement *ab*, *cd* and *ef* in each case.

Result : Since the ratio $\frac{x}{d}$ is the same in each case within experimental error, the displacement of the ray is directly proportional to the thickness of the glass slab for the same incident ray.

Precautions :

1. Alpins should be fixed exactly vertical.

2. The direction of rays should be marked by arrows.

3. Not only the heads but the feet of the pins should also be in the same straight line

4. Pins should not be fixed by hammering them by glass slab, but should be simply pressed by the thumb. For this, the tips of the pins should be well pointed.

ORAL QUESTIONS

Q. 1. *What do you mean by emergent ray and angle of emergent ?*

Ans. The incident ray, when enters the glass slab, gets refracted. This refracted ray, when comes out of the glass slab after further refraction, is called emergent ray The angle between the emergent ray and the normal at the emergent point is called angle of emergent.

Q. 2. *Is the emergent ray always parallel to the incident ray ?*

Ans. It happens so only in the case of rectangular glass slab.

Q. 3. *What do you mean by lateral shift ?*

Ans. Inspite of the fact that the emergent ray is parallel to the incident ray in case of a rectangular glass slab, the two are not along the same straight line but the former is displaced laterally from the later. This displacement is known as lateral shift.

Q. 4. *How does the lateral shift relate with the thickness of the glass slab ?*

Ans. The lateral shift (d) is related with thickness (x) of the glass slab by the formula :

$$d = x \sec(r) \sin(i - r)$$

where $\angle i$ and $\angle r$ are the angle of incidence and angle of refraction respectively. From this formula it implies that the ratio $\frac{x}{d}$ is constant for a given angle of incidence.

(Also see Oral Questions of Experiment 2.13)

EXPERIMENT 2.16

To study refraction of light through a glass prism and to determine the refractive index of glass.

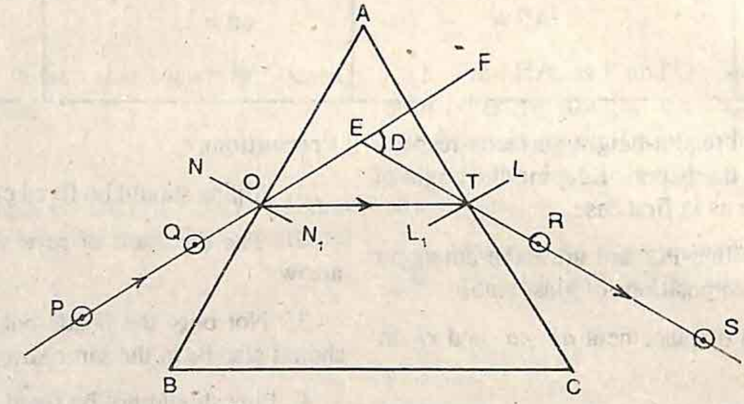


Fig. 2.16.1

Apparatus: A drawing board, drawing pins, drawing paper, aplins and a prism.

Procedure :

1. Fix the drawing paper on drawing board with the help of drawing pins.

2. Divide the paper into four equal parts with the help of a pencil and a scale.

3. Place the prism in the middle of each part and trace boundary ABC of the prism.

4. Draw the perpendicular NON_1 on the middle point O of AB.

5. Draw the straight line PQ making an angle of 30^0 with this perpendicular in first part. Take this angle equal to 35^0, 40^0 and 45^0 in other parts.

6. Place the prism in first part and fix two alpins on the straight line PQ such that alpins are about 2 cm. away from each other.

7. Seeing the glass prism from other side, fix two other alpins at R and S such that all the four alpins are in the same straight line.

8. Draw a straight line joining R and S which cuts the line AC of the prism at T. Produce the line PQ in forward direction and line RS in backward direction which meet each other at E. Draw a perpendicular LTL_1 at T.

9. Measure the angle of incidence ∠QON, angle of emergent ∠RTL and angle of deviation ∠FET.

10. Repeat the same process in rest of parts for angles of incidence 35^0, 40^0 and 45^0. Repeat the process also for angles of incidence 50^0, 55^0, 60^0, 65^0 and 70^0.

11. Measure the angle between any two boundary lines of the prism. This is known as angle of refraction of the prism (A).

12. Draw a graph between angle of incidence $\angle i$ along X-axis and corresponding angle of deviation ∠D along Y-axis. The ordinate of the lowest point on the graph gives the angle of minimum deviation $\angle D_m$. Calculate the refractive index (μ) of glass by the formula :

$$\mu = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Observations :

Angle of refraction of prism (A)=.....

S. No.	*Angle of incidence (i)*	*Angle of emergent (e)*	*Angle of deviation (D)*	*(i + e)*	*(A + D)*
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Calculations :

1. Find out D_m from the following graph :

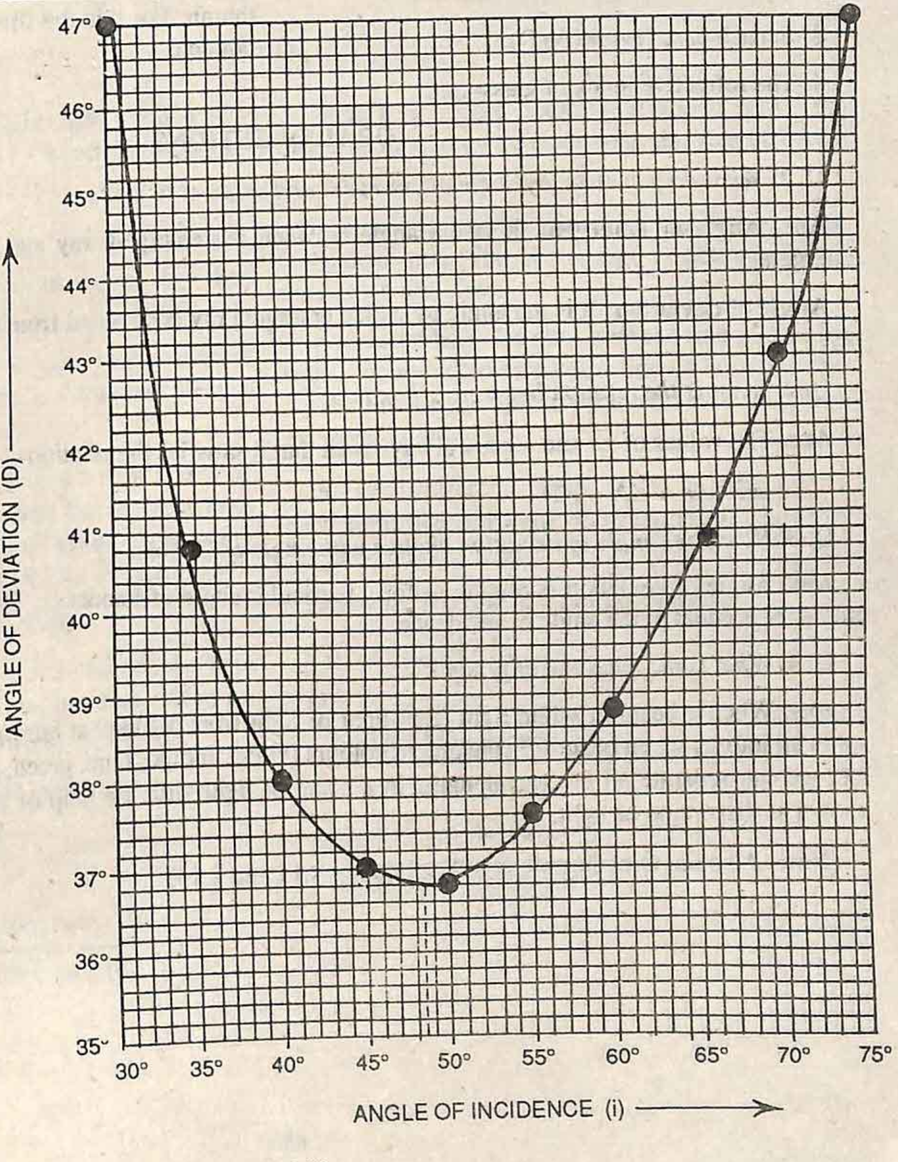


Fig : 2.16.2

2. Knowing ∠A=60^0 and D_m =......, find out μ as follows :

$$\mu=\frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Result :

1. When a ray of light passes from rare medium to denser medium, it bends towards the normal.

2. Angle of deviation changes with change of angle of incidence.

3. In each case $(i+e)=(A+D)$.

4. The refractive index of glass=......

Precautions :

1. Alpins should be fixed exactly vertical.

2. The difference of angle of incidence should not be less than 5^0.

3. The direction of rays should be marked by arrows.

4. Not only the heads but the feet of the pins should also be in the same straight line.

5. Pins should not be fixed by hammering them by glass prism, but should be simply pressed by the thumb. For this the tips of the pins should be well pointed.

ORAL QUESTIONS

Q. 1. *What do you mean by angle of emergent and angle of deviation ?*

Ans. Angle of emergent: It is the angle between the emergent ray and the normal at the point of emergent.

Angle of deviation: It is the angle by which emergent ray is deviated from the direction of the incident ray.

Q. 2. *What is the relation between ∠i and ∠e ?*

Ans. The values of ∠*i* and ∠*e* are always such that it satisfies the relation—

$$\angle i+\angle e=\angle A+\angle D$$

Q. 3. *How does angle of deviation change with angle of incidence ?*

Ans. Angle of deviation is minimum for a particular angle of incidence. Only in such a case, angle of emergent is equal to the angle of incidence.

Q. 4. *What is the main use of prism ?*

Ans. When a beam of white light (Sun light or light from a filament lamp) passes through a prism, it splits up into its seven beautiful constituent colours (violet, indigo, blue, green, yellow, orange and red). In fact we can separate all the wavelengths in a beam of light with the help of prism. This phenomenon is known as dispersion of light.

(**Note.** Also see Oral Questions of Experiment 2.11 and 2.13)

EXPERIMENT 2.17

To design and construct a pinhole camera and explain image formation.

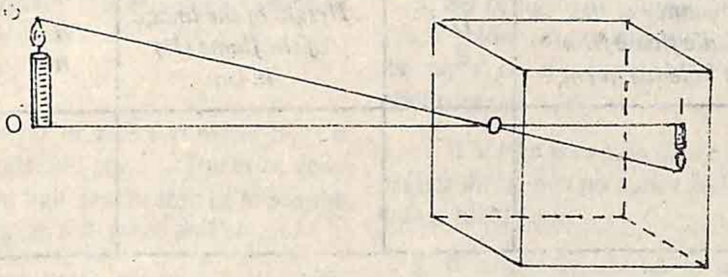


Fig. 2.17

Necessary materials : A light tight wooden box having a fine hole at the front face and a translucent ground glass plate at the back.

Procedure :

1. Take a wooden box or an empty box (of chalks) of card board.

2. Make a very fine hole at one of the vertical faces with the help of an alpin or a fine nail (if it is a wooden box).

3. Remove the card board or wooden board of the face just opposite to the face having fine hole and fix a translucent of round glass plate in its place with the help of some glue like Fevicol.

4. Your pin-hole camera is ready.

5. Bring the flame of the candle before the hole of the camera. You will find its inverted image on the ground glass plate as shown in the figure.

6. The principle of pin-hole camera is

$$\frac{\text{Size of the image (H)}}{\text{Size of the object (h)}} = \frac{\text{distance of the image from hole (D)}}{\text{distance of the object from hole (d)}}$$

since h & D are constant, it shows when the object is moved away from hole, the size of image decreases and vice versa.

7. Pin-hole camera gives a clear image free from distortion. The best image is obtained when the hole is very fine.

8. A large hole does not give the fine image, for it may be regarded as a collection of large number of small holes so close to each other that they form overlapping images.

9. Take different values of 'd' & measure 'H' each time. Record your observations as shown in the table on next page.

Result : We find in a pin-hole camera

$$\frac{H}{h} = \frac{D}{d}$$

i.e.

$$\frac{\text{Size of the image}}{\text{Size of the object}} = \frac{\text{distance of the image from hole}}{\text{distance of the object from hole}}$$

Observations :

1. Height of the candle flame (h) =..........cm

2. Distance between the screen and the pin-hole (D) =.......cm.

S. No.	Distance of the candle flame from the hole (d) in cm.	$\frac{D}{d}$	Height of the image of the flame (H) in cm.	$\frac{H}{h}$	Difference $\left(\frac{D}{d} \sim \frac{H}{h}\right)$
1.					
2.					
3.					

EXPERIMENT 2.18

To learn how to determine the colour blindness through colour perception test.

Necessary materials : Three bright screens of red, green and blue colour.

Procedure :

1. The sensory layer or retina consists of two types of cells, the rods and cones. The cone cells are sensitive to bright light and enable us to see the three primary colours i.e. red, green and blue.

2. There are three types of cone cells, each having a different pigment. The absence of any of these pigment results in the failure to see the corresponding colour.

3. So bring one by one the red colour screen, green colour screen and blue colour screen before the eyes of a person to check his/her colour blindness.

4. If he/she is unable to see any colour, it means his/her retina has no cones and said to suffer from colour blindness.

5. If he/she is unable to see one or the two colours, it means the corresponding cone is absent from his/her retina.

EXPERIMENT 2.19

To determine the least distance of distinct vision.

Procedure :

1. The least distance of distinct vision is the least distance up to which our eye can read a book distinctly without straining the eyes.

2. To determine the least distance of distinct vision of your eyes bring a book close to the eyes at such a least distance that you can read the book distinctly without straining your eyes.

3. Measure the distance of the book from your eyes with the help of a half-metre rod. This distance is the least distance of distinct vision of your eyes.

4. Measure the least distance of distinct vision of few of your friends. You may find it is different for your different friends.

5. The least distance of distinct vision for normal eye is 25 cm.

EXPERIMENT 2.20

To construct simple working models of microscope and telescope.

Necessary materials : Two cylindrical tubes, two convex lens say one of focal length 5 cm and the other 50 cm.

Procedure :

1. Take two cylindrical tubes such as case of shuttle cocks so that one tube may just slide into the other. You can also make two tubes yourself so that just one may slide into the other with the help of cardboard, paper, gum etc. Take two card boards (40 cm × 18 cm & 40 cm × 17 cm). Wrap them to make cylinder and stich them.

2. Fix on the one end of each tube one convex lens with paper on sides with gum. Then cover curved surface with paper to decorate it.

3. Insert smaller tube in diameter into bigger tube so that their open ends are facing each other [Fig. 2.20.1 (a) and b)]

4. To make it a microscope, hold the 5 cm focal length's convex lens towards the object. Seeing through the other lens of 50 cm focal length by keeping one eye on this lens and keeping the other eye closed, adjust the distance between the two

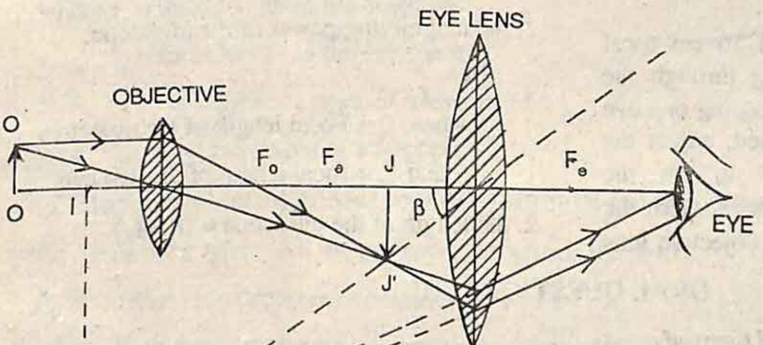


Fig. 2.20.1 (a)

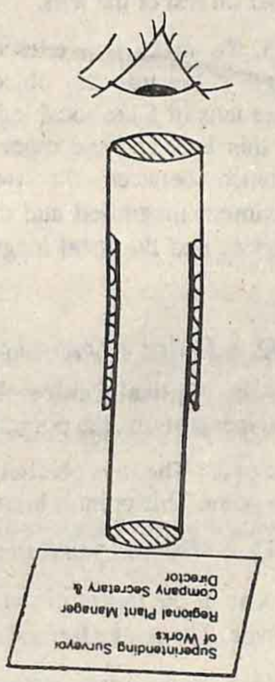


Fig. 2.20.1 (b) Outer look of a Microscope

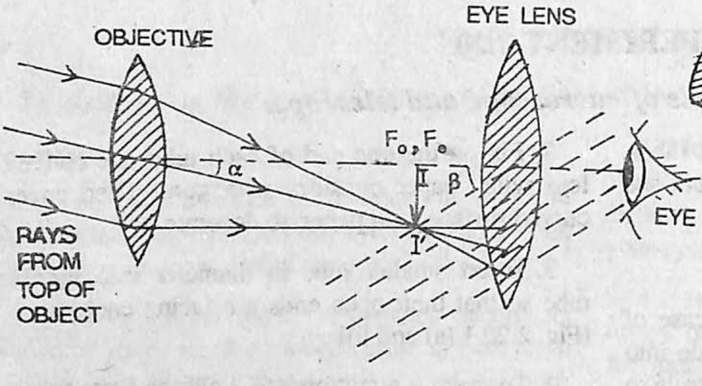


Fig. 2.20.1 (c) Telescope

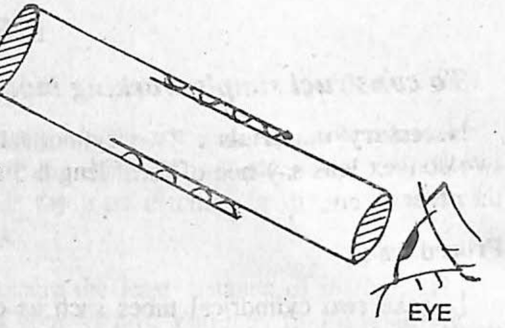


Fig. 2.20.1 (d) Outer look of a Telescope

lenses to get the maximum magnified and distinct image of the object . For this, you must also adjust the distance of objective lens from the object. [see Fig. 2.20.1 (a)]. In this case aperture of the object lens should be reduced to about 1 cm by pasting paper on rest of the lens.

5. To make it a telescope, hold 50 cm focal length's towards the object. Seeing through the other lens of 5 cm focal length by keeping one eye on this lens and the other eye closed, adjust the distance between the two lenses to get the maximum magnified and distinct image. Here the aperture and the focal length of the objective lens should be large so that a well magnified, resolved and bright image of the distant object may be obtained [Fig. 2.20.1(c)]–Fig. 2.20.1 (d) shows outer look of the telescope.

For normal adjustment in the Fig. 2.20.1 (c)

1. the magnifying power of the telescope,

$$M = \frac{f_o}{f_e}$$

where f_o = Focal length of the objective

and f_e = focal length of the eye lens.

2. the length of the telescope = $(f_o + f_e)$

ORAL QUESTIONS

Q. 1. *Define the optical centre and focus of a lens.*

Ans. Optical Centre: If a ray of light passes through the lens such that the incident ray is parallel to the emergent ray, the point, at which the refracted ray cuts the lens is known as optical centre.

Focus: The rays parallel to principal axis of the lens after refraction through it meet or appear to meet at a point. This point is known as focus of the lens.

Q. 2. *How will you distinguish between concave and convex lens without touching them ?*

Ans. If the image of the finger of the hand formed by the lens is inverted, smaller or larger, the lens is convex. The image formed by concave lens is always erect and smaller.

Q. 3. *Name a few instruments in which convex lens is used.*

Ans. Any type of telesceope, microscope, periscope, binocular, etc.

Q. 4. *What is the utility of a concave lens ?*

Ans. When we want to obtain the erect image of an object situated at a far distance, we use concave lens, *e.g.*, in Galelian telescope.

Q. 5. *Why is the convex lens known as converging lens and concave lens as diverging lens?*

Ans. Rays of light, on passing through a convex lens, converge at a point while on passing through a concave lens, the rays appear to diverge from a point.

Q. 6. *What do you understand by the power of a lens ?*

Ans. The power of the lens is equal to the reciprocal of its focal length in metres and it is measured in diopter.

Q. 7. *What is a telescope ?*

Ans. It is a instrument to see the far objects distinctly. It makes the final image of an object magnified and at the least distance of distinct vision of the eye.

Q. 8. *What is the magnification power of the telescope ?*

Ans. It is defined as the ratio of the angle subtended by the final image at the eye to that by the object at the eye. For normal adjustment in which the final image is formed at the focus of the eye lens, magnification power,

$$M = \frac{f_o}{f_e}$$

where f_o = focal length of the objective

f_e = focal length of the eye piece

Q. 9. *What are different types of telescopes ?*

Ans. These are two types of telescopes :

(a) Refracting type : e.g. Astronomical, Terrestrial and Galelian etc.

(b) Reflecting type : All the modern telescope of the world.

Q. 10. *What is the difference between the two ?*

Ans. Both use same type of eye piece consisting of lenses, but objective is a convex lens in a refracting type telescope while it is a concave mirror in reflecting type telescope.

The world's largest telescope is in U.S.S.R. having objective as concave mirror of aperture 234 inch.

Q. 11. *What is a microscope ?*

Ans. It is an optical instrument to see the image of near objects very small in size after magnification.

Q. 12. *What is the formula for its magnification power ?*

Ans. Its magnification power 'M' is given by

$$M = \frac{V}{U}\left(1 + \frac{D}{f_e}\right)$$

where, D = Distance of the distinct vision

f_e = focal length of eye lens

In order to increase M, we have to keep object distance U very small. Since the object must be placed beyond the focus of the objective, it means the focal length of the objective must be very small.

Q. 13. *What are different types of microscopes ?*

Ans. 1. Simple microscope which uses only one convex lens.

2. Compound microscope which uses number of convex and plano-convex lenses.

3. Electron microscope which uses an electron beam deflected by magnetic field. Its magnification power is 100,000 and resolving power also very high.

Q. 14. *What do you mean by resolving power of an instrument ?*

Ans. It is the ability of the instrument to show two very close objects as separate one.

Q. 15. *What do you mean by the length of the microscope and the telescope ?*

Ans. It is the distance between the objective and the eye lens which is equal to the sum of the focal lengths of the objective and the eye-lens for normal adjustment.

UNIT 3

WAYS OF LIVING

Introduction

"Biology is the branch of Science under which we study about all the activities related to life of the living beings."

The practical aspect related to every branch of Science is done in a definite room of school in which the essential apparatuses are kept. This room is called '*LABORATORY*'.

The laboratory related to Biology is named as '*Biology Laboratory*'.

Students have to follow the following rules before entering the Biology Laboratory.

1. The students should bring practical book, Practical record file, one Drawing brush No. 3, Dissection box, one Pencil (H. B.), one eraser, one pen, one duster, one blade etc. with them.

2. They should enter the laboratory according to serial number or according to the allotted seats. They should sit at their allotted place.

3. They should not talk or make any noise in the laboratory.

4. They should listen the teacher carefully and should do work according to his instructions.

5. They should not touch to any thing of the laboratory like chart, model, apparatus, chemicals etc. without the permission of the teacher.

6. They should not touch to any chemical without the permission of the teacher.

7. They should put the washed apparatus at its proper place after finishing the practical work.

8. As the practical is completed, they should write the Practical on the practical record file and should get it signed by the teacher on the same day or on the next turn.

9. They should be careful about the cleanliness of their seats and near by.

10. They should clean their hands with the help of soap just after finishing the practical work.

11. They should use the brush, glass rod, dropper or any other thing after thoroughly wash with clean water from one chemical to the other chemical.

ORAL QUESTIONS

Q. 1. *What is Biology ?*

Ans. Biology is the branch of Science which deals with the living beings.

Q. 2. *What is a Biology Laboratory ?*

Ans. Biology laboratory is a place or room where Biology Practicals are conducted.

Q. 3. *What things must be kept by a student at the time of entering the Biology Laboratory ?*

Ans. A student should keep the following things with him at the time of entering the Biology Laboratory. Practical Book, Practical record file, one Drawing Brush No. 3, Dissection Book, one pencil of H. B., one eraser, one pen, one duster and one blade.

Practical Note-Book

Practical note-book is a special type of note-book in which ruled and drawing sheets are fixed alternately. When we work on the Practical note-book, we should consider the following points :

1. Ruled and drawing sheet should be arranged alternately.

2. Drawing work can be done on both the sides of the drawing sheet in *Zoology* and written work can also be done on both the sides but in *Botany* drawing work is done only on the left side of the drawing sheet. The related experiment is written on the side ruled paper. If the whole statement of the experiment is not written on the same page, the remaining part can be written on the right side of the next page. Students should work according to the instructions of the teacher concern.

3. In Zoology section, the figures should be drawn according to the description written on the front ruled page. The maximum number of figures on one side of one drawing sheet is four. The same condition is in Botany but the maximum number of figures on one side of a drawing sheet is two.

4. The name of the figure should be written in capital letters either on the lower side or on the upper side of the figure putting a mark underline. Labelling and naming should be done with pencil.

5. The labelling of every part of the figure should be in one language and in one script. If the labelling is in English the first letter of each name should be written in capital letter while the remaining part of the name should be in small letters.

6. The labelling of the diagram should be done in such a way that the blank space of the sheet may cover and the diagram may look nice. For such a work, the whole diagram is divided into two equal parts horizontally. The names of the parts or organs of upper half should be written on one side of the sheet while the remaining names of lower half should be written on the other side of the sheet. If the diagram is rounded, the names should be written from centre to periphery or vice-versa.

7. Mark the space line on the drawing sheet and put down the date.

8. Student should not use pen ink, refill pencil and copying pencil on the drawing sheet.

9. The comments regarding the diagram should be written in brief and to the point, not in detail.

10. All the papers should be arranged date-wise in the Practical file.

11. Student should write name, class, section, roll no. etc. in legible handwriting on the first page of the file.

Method of Writing of Experiment

The whole experiment, done in the laboratory, is divided in the following sub-heads when it is written in the Practical note-book:

Object : It means the aim of the experiment. We should write that aim under this head to which we want to achieve through this experiment.

Required Materials : Under this head, those materials are mentioned which are used in the experiment.

Method of setting the apparatus : In this head, we write about the method of setting of apparatus and the relation of each part with the other.

Procedure : In this head, method of starting the experiment is explained. We also explain the materials and factors which are used in the experiment. We also explain the last stage of the experiment just to achieve the object and time taken in completing the experiment.

Observation : We write the main findings systematically received during the experiment. We can write all the findings either in the form of paragraph or in the form of table.

Result : We should write the final finding after completing the experiment.

Precaution : All the precautions taken from the beginning to the end for the success of the experiment are written under this head.

ORAL QUESTIONS

Q. 1. *What type of the Biology Practical Note-book should be ?*

Ans. A Biology Practical Note-book contains loose leaves i.e. drawing sheets and ruled papers arranged alternately.

Q. 2. *What are the main steps for writing the experiment ?*

Ans. Main steps of writing experiments are — (a) Object, (b) Required material, (c) Method of setting the apparatus, (d) Procedure, (e) Observation, (f) Result and (g) Precautions.

Q. 3. *Which precautions must be kept into consideration at the time of drawing the figure ?*

Ans. (a) The figure should be enlarged enough.

(b) Each and every part or organ should be labelled.

(c) Only one language should be used in labelling.

(d) Labelling should be made on both sides of the figure in legible handwriting.

(e) The name of the experiment or figure should be written in Bold alphabets.

(f) Only H.B. lead pencil should be used in sketching and labelling.

Material Available in the Laboratory

Students get the following material in the Laboratory:

(a) Dissecting table.

(b) Dissecting tray.

(c) Anaesthised animal for dissection.

(d) Plant part for practical work.

(e) Microscope.

(f) Stains (e.g., Eosin, Safranin, Fast green, Borax Carmine, Glycerine, Acid water)

(g) Plain glass slide.

(h) Cover slip.

(i) Watch glass.

(j) Petri dish.

(k) Alpins.

(l) Spirit lamp.

(m) Test tube.

(n) Test tube holder.

(o) Flask.

(p) Beaker.

(q) Preserved specimens of living beings.

(r) Light lamps.

(s) Some specific apparatus related to experiments.

(t) Needles.

(u) Coloured and smooth paper for display.

(v) Match box.

(w) Needles.

Students should bring the following material with them :

(i) Practical note-book.

(ii) Pencil of H.B.

(iii) Rubber or Eraser.

(iv) Dissection Box.

(v) Blade.

(vi) Practical guide book.

(vii) Handkerchief.

(viii) Pen.

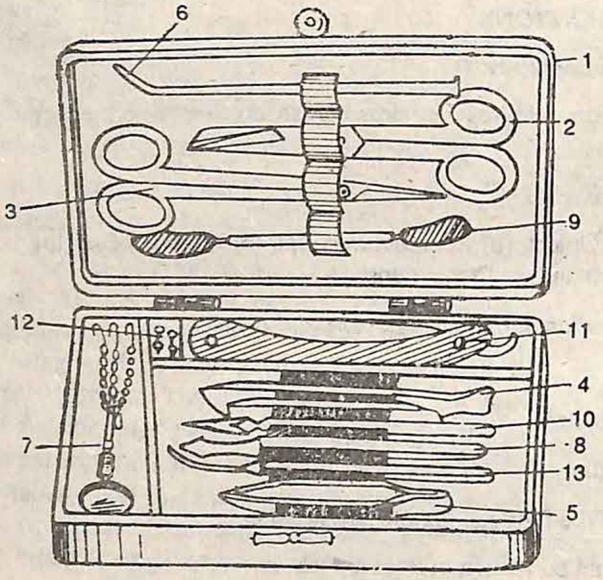


Fig. 3.1 Dissection Box

Dissection Box :

Dissection Box is the box of all the instruments used in Biology practical. This box should contain the following instruments :

(i) Two scalpels.

(ii) One large scissors.

(iii) One small scissors.

(iv) One large forcep.

(v) One small forcep.

(vi) One Blow-pipe.

(vii) One bunch of hooks with chain.

(viii) One arrow.

(ix) Flat spoon or spatula.

(x) Big needle.

(xi) One big razor.

(xii) Alpins.

(xiii) One dropper.

(xiv) One brush No. 3.

(xv) One hand lens.

(xvi) One needle with handle.

Every student must have one dissection box of his own so that he may not ask any instrument from others during practical work.

ORAL QUESTIONS

Q. 1. *What are the things available for Zoology Practical in the laboratory?*

Ans. (a) Dissecting table, (b) Dissecting tray, (c) Anaesthesised animal for dissection, (d) Hand lens, (e) Water, (f) Practical material, (g) Plain slide, (h) Coverslips, (i) Alpins, (j) Stains with glycerine.

Q. 2. *What are your requirements from laboratory for Botany Practical ?*

Ans. (a) Watch glass, (b) Petri dish, (c) Plain slide, (d) glycerine, (e)Microscope, (f) Stains, (g) Clean water.

Q. 3. *What is a Dissection Box ?*

Ans. Dissection box is a box in which all the instruments are kept safe.

PREPARATION OF TEMPORARY MOUNTING

Method of Preparation :

Cut fine sections of the provided material. Put them in the watch glass containing water with the help of brush. Take a plain slide. Wipe it with the piece of cloth. Select one fine section. Put it on the slide with the help of brush. Put one or two drops of the stain on the section instructed by the teacher with the help of dropper. Keep the section in the same position for half to one minute and then transfer it in the water with the help of brush.

Wash the plain slide and brush with water. Now put the stained section on slide and examine whether the section is stained as desired or not. If the section is stained in excess, put a drop of acid water on the section and rub the brush slightly. Till the excess colour is removed from the section. Transfer it again in the water.

Now take clean and dry plain slide and put a drop of glycerine on it in the centre. Now put the stained section on the glycerine drop.

Take a cover slip. Wipe it with dry piece of cloth. Now put the cover slip on the slide in such a way that its one end touches the edge of glycerine. Put the cover slip vertically of the slide using the needle as support. Bend the upper end of cover-slip so that it may cover the section and the remaining glycerine. Note that no air bubble should remain in between cover slip and slide. Do not remove the needle till the other end of the cover slip touches the slide. Thus temporary mount of the provided material is prepared.

If some amount of glycerine is taken out from the cover slip, remove it with the help of a small piece of blotting paper or pressed surgical cotton. Note that the blotting paper or pressed cotton should not absorb excess amount of glycerine from within the cover slip.

If the amount of glycerine is less in quantity, put small quantity of it from that side where the quantity is short and complete the space of cover slip.

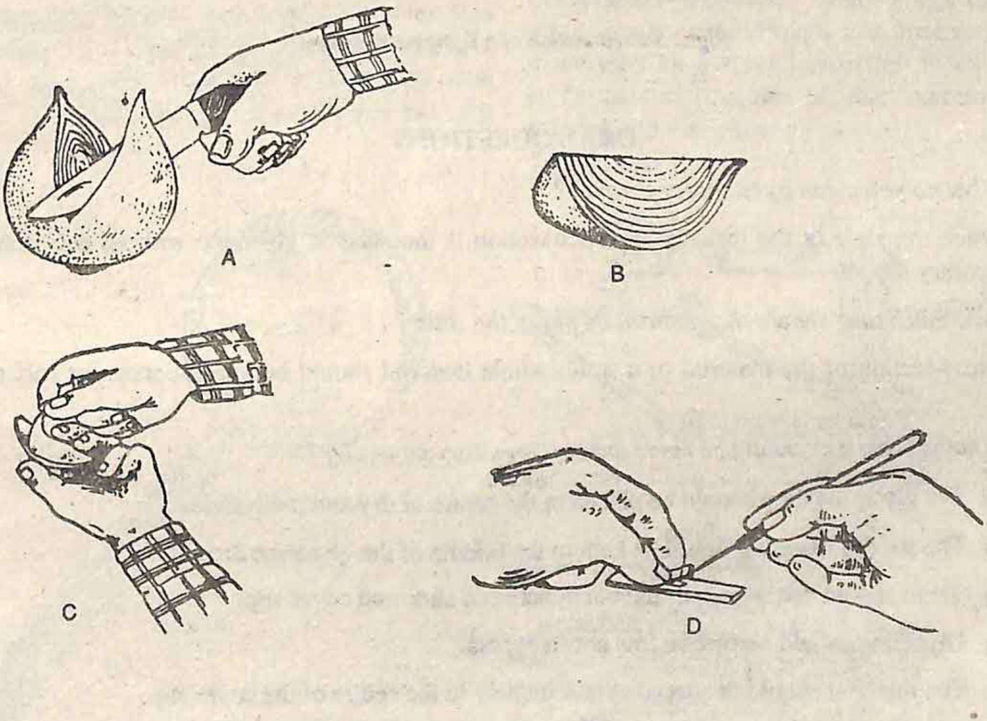


Fig. 3.2 How to prepare a wet mount of an Onion Peel

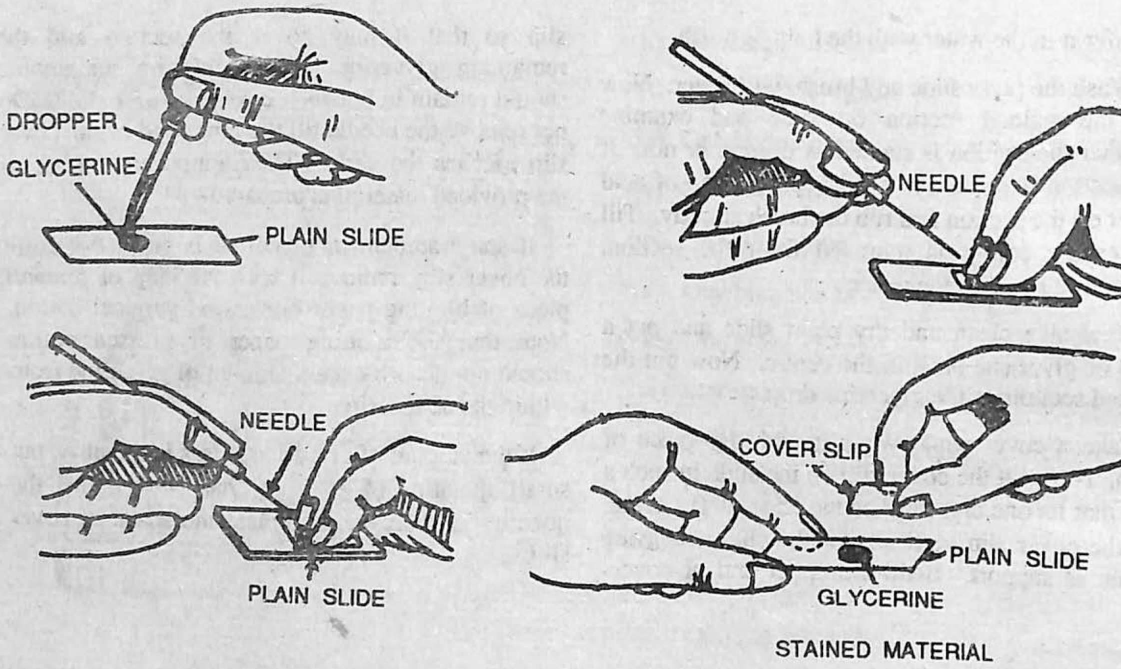


Fig. 3.3 Preparation of a Temporary Mount

ORAL QUESTIONS

Q. 1. *What do you mean by temporary mount ?*

Ans. When the slide of the material or cross-section is mounted in glycerine without dehydration is called temporary mount.

Q. 2. *How much time should the material be put in the stain ?*

Ans. Cross-section of the material or a small whole material should be kept in stain for half or one minute.

Q. 3. *What precautions should be made during temporary mounting ?*

Ans. (a) The glycerine drop should be placed in the centre of dry and plain slide.

(b) The stained material should be kept in the middle of the glycerine drop.

(c) There should not be any air bubble in between slide and cover slip.

(d) Glycerine should neither be less nor in excess.

(e) The material should be placed approximately in the centre of the cover slip.

Q. 4. *Explain whether the stained material should be placed over the glycerine or glycerine should be over the stained material.*

Ans. Stained material should be placed over the glycerine.

EXPERIMENT 3.1

Study of the main structural parts of the microscopes (hand lens, dissecting and compound) and to know their utility, setting and precautions to be taken while working on them.

Generally in the Biology Laboratory of Class IX and X the following three main types of microscopes are used :

(1) Hand Lens

There is one biconvex lens surrounded by a circle of steel or plastic sheet. One handle is also attached with the circle. It enlarges five times to the object.

(2) Simple Dissecting Microscope

This instrument is also used for the enlargement of the object. The minor object is dissected under this microscope. It enlarges the object fifty times.

Structure : There is a powerful biconvex lens surrounded by a steel circle which is fixed in a folding steel rod. This rod is connected with another rod which is vertically arranged with the 'U'-shaped base. This vertical rod moves up and down with the help of screw called as 'Adjustment screw'. The moving rod is surrounded by a fixed, vertical and hollow rod. There is a square-shaped glass plate fixed outside to the hollow tube which is called 'stage' or 'Platform'. The observing material is put on this platform. There is a circular mirror placed below the platform. It reflects the sunlight towards the platform. There are two clips attached on either side of the platform which are used in fixing the object on the platform.

(3) Compound Microscope

This microscope is also named as Students' Compound microscope. Minor things (upto 0.001 mm.) can be seen through this microscope. It is made up with a special type iron metal. For the study of the structure of this instrument, it is divided into the following parts :

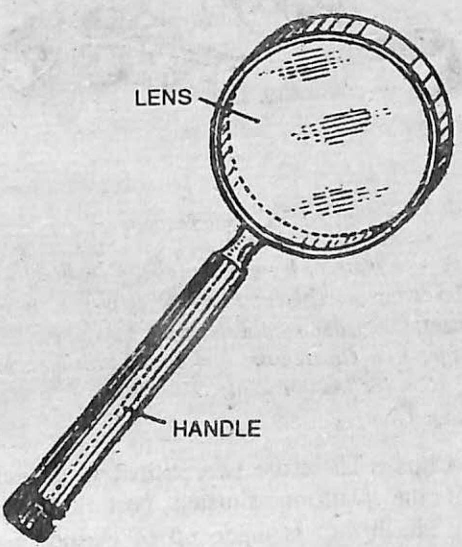


Fig. 3.1.1 Hand lens

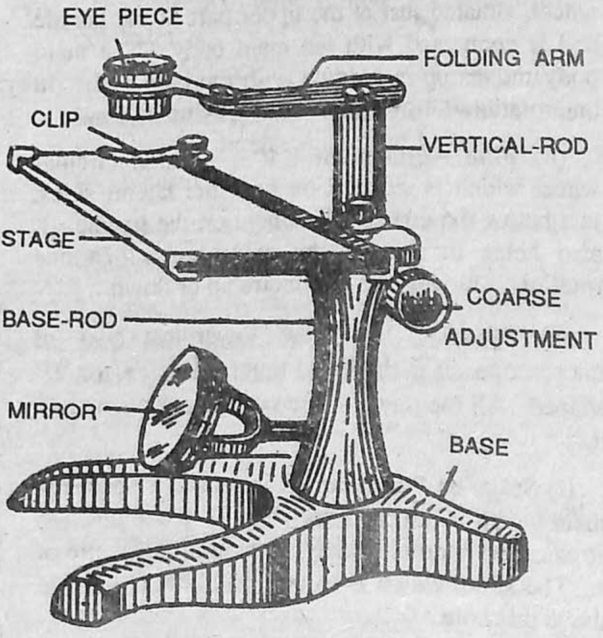


Fig. 3.1.2 Simple dissecting microscope

(a) **Handle** : It is thick, tough and semi-eliptical shaped like saw machine. The whole instrument is displaced with the help of it. It connects the main body with other parts.

Two circular, solid structures are attached with its upper end which are known as 'adjustments'.

(b) **Main Body** : It is a cylindrical rod shaped structure, which is open at both the ends. There a biconvex lens placed at the upper end which is named as 'Eye piece or Eye lens'.

(c) **Objective Lens** : There is a flat and circular disc attached with the lower end of the main body which is called 'Nose piece'. Three biconvex lenses of different power are fixed at different places on the nose piece. These lenses are called objective lenses. These objective lenses can be adjusted according to the requirement.

(d) **Adjustment** : Adjustment is a wheel through which we adjust the apparatus according to the need. Generally there are two adjustments which are named as coarse adjustment and the fine adjustment respectively.

(i) **Coarse Adjustment** : It is a big circular wheel, situated just at the upper part of the handle and is connected with the main body. The main body moves up and down with the help of it. In one rotation it moves one centimetre up or down.

(ii) **Fine Adjustment** : It is a small circular wheel which is situated on both the lateral sides, just below the coarse adjustment on the handle. It also helps in moving the main body. In one rotation, it moves one millimetre up or down.

(e) **Stand** : It is the lowermost part of microscope. It is thick and tough. It is 'V' or 'U' shaped. All the parts of microscope are situated on it.

(f) **Stage or Platform** : It is square-shaped iron sheet which is attached horizontally at the junction of base and handle. There is a hole in the centre of it. The slide, which is to be examined, is put just above this hole.

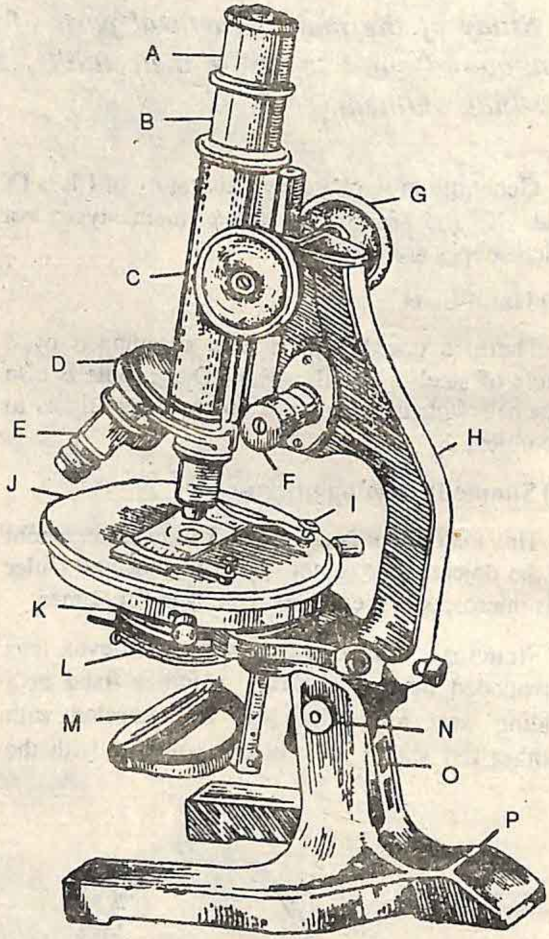


Fig. 3.1.3 The microscope

(Key : A = Eyepiece; B = Draw-tube; C = Body-tube; D = Revolving nosepiece; E = Objective; F = Fine adjustment; G = Coarse adjustment; H = Arm; I = Clip ; J = Stage; K = Condensor; L = Iris-diaphragm; M = Mirror; N = Inclination joint; O = Pillar; P = Horse shoe-shaped foot)

(g) **Clips** : There are two clips, one on either side of the platform situated posteriorly near handle. Each clip is made up of elastic metal. These clips are attached with the platform with the help of screw. They help in keeping the slide on the platform.

(h) **Condenser** : It is a special, circular structure situated just below the hole of the platform which can be moved in the circular way with the help of a small handle. It makes the hole small or large according to the need of light required for the clarity of the placed material.

(i) **Mirror** : There is a circular mirror situated horizontally in the centre of the vertical tube of the base. It is plain on one side and concave on the other side. This mirror is fixed in the semicircular metal grip. This mirror can be moved in any direction according to the requirement. It reflects the sunlight towards the hole of the platform. This sunlight helps in seeing the mounted object placed on the platform.

Setting of Compound Microscope : Before examining the slide, microscope has to set up. The microscope is set up in the following way :

(i) First of all put the microscope on the table facing towards the light side.

(ii) Adjust the mirror of the microscope in such a way that the light may reflect on the aperture or hole of the platform.

(iii) Now place the slide on the platform such that the material which is to be seen may come just above the hole of the platform.

(iv) At first the low power objective lens should be adjusted just above the hole of platform.

(v) Let the body of the microscope be moved with the help of coarse adjustment such that the material of the slide could be seen.

(vi) To make the vision distinctly move the body up or down with the help of fine adjustment.

(vii) If the material of the slide is seen under high power change or replace the low power objective lens from high power objective lens and then again adjust the body with the help of fine adjustment .

Precautions for the microscope : The microscope is very fine and sensitive instrument used for examining the micro-objects, so it is very clear that it should be kept and used with full precautions. The following precautions should be observed while using and keeping the microscope.

Precautions while using the microscope :

(i) The wiper or duster which is to be used for microscope should be of cotton.

(ii) It will be better if the duster is of white colour.

(iii) The duster should be properly washed and dry and should not be used for any other purpose.

(iv) The eye piece, objective lens and mirror should be thoroughly wiped of with the help of dry and clean duster.

(v) The objective lens of low power should be used for adjusting the microscope and then should be replaced with the high power.

(vi) The slide, to be put on the platform, should be dry and clean. There should be no colour or glycerine above the coverslip and all around it outside.

(vii) The objective lens should not touch the coverslip.

(viii) If the microscope is to displace, it should be handled from the handle which is semicircular in shape situated between body and platform.

(ix) The slide with material should not remain on the platform after use.

(x) The microscope should be covered if it is not used for short time with the help of a Polythene covering or by wooden box.

Precautions while keeping the microscope for a long time :

(i) The microscope after finishing the practical or work should be kept in the wooden box under lock and key.

(ii) The objective lenses should be near the platform but not facing to the platform.

(iii) The duster should also be kept along with the microscope.

(iv) The box should not tilted or conversed.

(v) The extra objective lenses and eye piece should remain in the box when they are not utilizing.

Utility of the microscope :

Microscope is the instrument which is cheap, easily handled and portable and with the help of which very tiny things can be observed.

(i) It is cheap in cost and easily available.

(ii) It can be repaired easily.

(iii) Every part of it can be replaced from the other or after proper repair.

(iv) The tiny organism or other material can be observed with the help of it.

(v) The interval organs in the functioning form can be observed with the help of it.

(vi) It is everlasting instrument if it is handled carefully.

ORAL QUESTIONS

Q. 1. *What is a microscope ?*

Ans. Microscope is an instrument used for observing tiny things clearly.

Q. 2. *Who discovered the microscope ?*

Ans. Robert Hooke discovered the microscope but later on A.V. Leeuwenhock made it better.

Q. 3. *How will you calculate the magnifying power of a microscope ?*

Ans. By multiplying the power of objective lens with the power of eye piece lens, the magnifying power of a microscope can be calculated.

Q. 4. *What is the use of condenser?*

Ans. Condenser is used to control the amount of light to be entered into the microscope.

Q. 5. *How do you set the microscope ?*

Ans. (a) The prepared slide is placed on platform in such a way that the material should lie just above the hole.

(b) First of all, we observe the slide under lower power and then in high power.

(c) For the adjustment in high power, we use 'fine adjustment' for the movement of body.

Q. 6. *What should be the position of mirror of the microscope ?*

Ans. The mirror of the lens should be tilted at its axis toward light in such a way that the reflection of the light rays should strike on the material of the slide.

EXPERIMENT 3.2

Study of plant cell (onion epidermis) and animal cell (cheek cells) under the microscope by taking their temporary mounts.

EXPERIMENT 3.2 (A)

Study the cells of plant cell (onion epidermis).

Required Materials : Onion, Dissection box, plain slide, cover slip, glycerine, eosine, stain, compound microscope, brush, water.

Method or Procedure : Take a fleshy leaf from the centre of the onion. Bend its one end outside in such a way that its inner thin layer breaks up. Now snatch its small piece slowly. You will find a very thin and transparent layer which is separated from the remaining part of the onion leaf. Take this transparent layer on the plain glass slide carefully. This layer is known as peeling. Pour one or two drops of eosine stain on it. Transfer this coloured peeling in the clean water with the help of brush. If the peeling is big enough, cut one square centimetre size of it with the help of scissors or blade. Now take a clean and dry plain glass slide. Put a drop of glycerine in the centre of it and then put the piece of coloured or stained peeling on it with the help of brush and then mount it with the cover slip. Examine it under microscope.

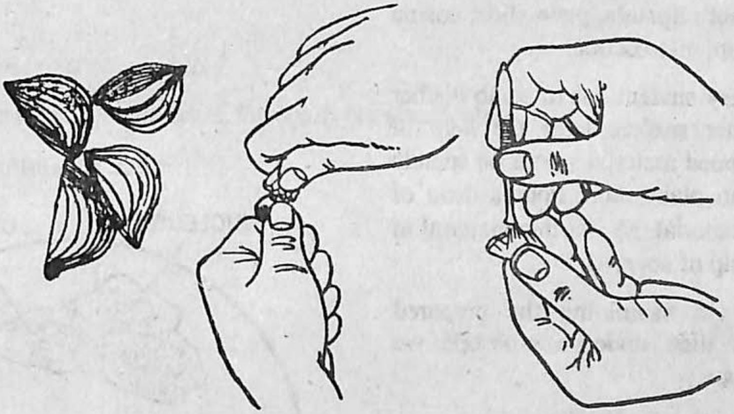


Fig. 3.2.1. Technique of peel removal

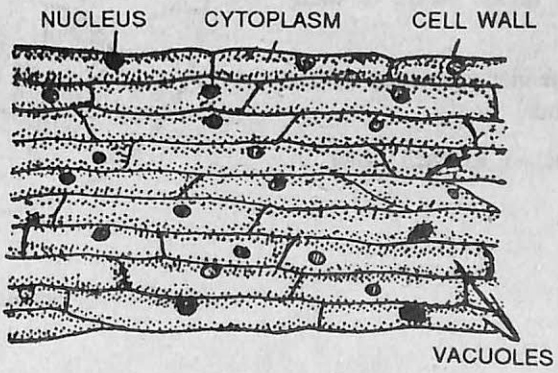


Fig. 3.2.2 Cells of onion peel

Observations :

(i) Almost all the cells are rectangular in shape.

(ii) Inter cellular space is absent.

(iii) Each cell is enclosed with a thin membrane.

(iv) Each cell contains a thick and spherical nucleus which is situated near the side.

(v) There is a big vacuole in the centre of the cell.

(vi) Slightly coloured cytoplasm is clearly visible in between cell membrance and vacuole.

Precautions :

1. Onion peeling should be of 1 cm square approximately.
2. The folds in the peel should be avoided.
3. Always use the brush while transferring the material from watch glass to the plain slide and vice-versa.
4. The material should neither be over stained nor under stained.
5. The stained material should be placed in the centre of the slide and coverslip.
6. Air bubbles should not be inside the coverslip.

EXPERIMENT 3.2 (B)

Study of animal cells (cheek cells) under microscope.

Required Material : Spatula, plain slide, eosine stain, water, cover slip, microscope.

Procedure : Every student has to scrab his/her cheek from the inner surface with the help of spatula. Put the scrabbed material stored on spatula on the dry and clean plain slide. Pour a drop of eosine stain on the material. Mount this material in glycerine with the help of cover slip.

Observations : On examining the prepared temporary mounted slide under microscope we observe the following :

(i) These cells are irregular in shape.

(ii) A nucleus is present in the centre of each cell.

(iii) Each cell contains granular cytoplasm which is slightly pink in colour.

(iv) These cells are attached to each other in uncertain manner.

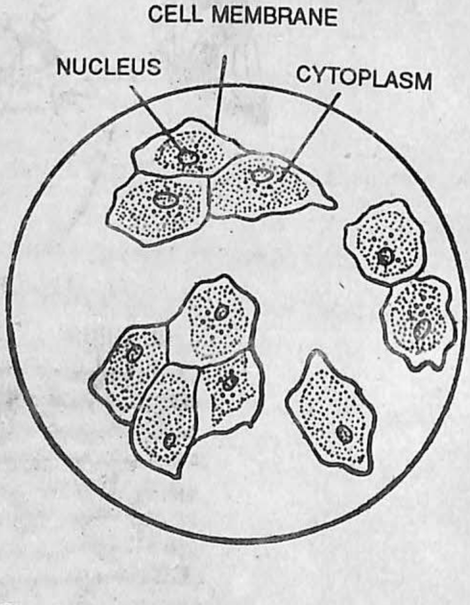


Fig. 3.2.3 Animal Epithelial Cells (cheek cells)

Precautions :

1. Always hold the slide by its edges so that the material on the slide may not disturb and dirty.
2. The stained material should be placed in the centre of the coverslip and uniformally spread on the slide.
3. Glycerine should neither be less nor too much. Glycerine outside the coverslip should be wiped of with the help of cotton or blotting paper.

ORAL QUESTIONS

Q. 1. *Which cell organelle provides a definite shape to the plant cell ?*

Ans. Cell wall.

Q. 2. *What is the scientific name given to the green organelles floating in cytoplasm of plant cell ?*

Ans. Chloroplasts.

Q. 3. *How the cells look like in onion peel ?*

Ans. The cells look like rectangular body.

Q. 4. *Are cheek cells and the cells of onion peel alike ?*

Ans. No.

Q. 5. *What is the shape of cheek cells ?*

Ans. Cheek cells are irregular in shape. Each cell is uninucleated.

EXPERIMENT 3.3

Study of plant and animal cells from prepared slides or temporary mounts to see the differences between them.

Required Material : Temporary mounts or permanent slides of epidermal peel cells of onion and epithelial cells of human cheek, microscope.

Procedure :

Examine both the slides under microscope separately, draw their diagrams, label their parts and then compare them.

Observation :

On studying both the slides you can compare them in the following way :

Epidermal Cells of Onion	Epithelial Cells of Human Cheek
Points of similarity :	
1. The cells are living.	1. The cells are living.
2. These cells contain cytoplasm and a nucleus.	2. There is also a nucleus floating in the cytoplasm.
3. These cells are forming a thin outer most layer of the leaves.	3. These cells also form a thin layer which forms the inner most layer of the cheek.
Points of difference :	
1. These cells are rectangular in shape	1. These cells are of various shapes.
2. There is a big vacuole in the centre of the cell.	2. The vacuoles are either absent or if present, they are very small and may be present at any place inside the cell.
3. Nucleus is present generally at one side of the cell.	3. Nucleus is generally present in the centre of the cell.
4. Inter cellular spaces are absent.	4. Cells are compact to each other and inter cellular spaces are absent.
5. The cell wall is thick, clear and of dark colour.	5. Cell wall is absent.

ORAL QUESTIONS

Q. 1. *In which cell one organelle is non living ?*

Ans. Cell wall of plant cell.

Q. 2. *In which cell centrosome is present ?*

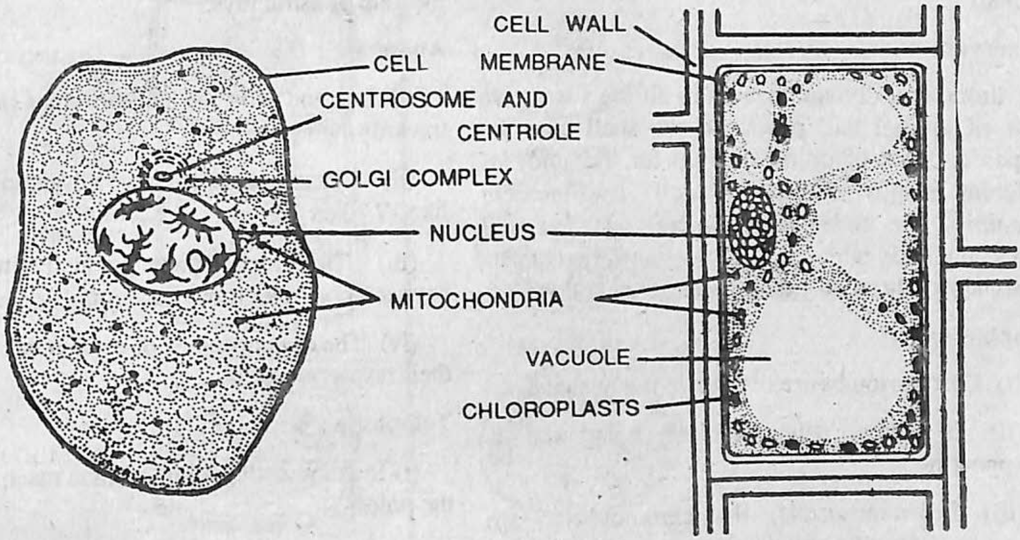
Ans. In animal cell.

Q. 3. *What are the main points of difference between the vocuole of animal cell and plant cell ?*

Ans. (a) The vacuoles in plant cells are large in size and in the centre of the cell while in animal cell they are small in size but their position in cytoplasm is indefinite.

(b) In plant cell the vocuoles have existance while in animal cell these vacuoles appear and disappear.

(c) In plant cell there is an inner membrane in the vacuoles known as tonoplasts while in animal cell this membrane is absent.



(a) Animal cell

(b) Plant cell seen under light microscope

Fig. 3.3

EXPERIMENT 3.4

(a) Study of cell division stages from permanent slides or from tips of shoot or root.

(b) Study the stages of mitosis either through prepared slides of onion root tips or through models or charts.

Required Material : Prepared slides of different stages of mitosis, microscope or models or chart.

Observation :

Mitotic cell division occurs in all the vegetative cells of animal and plant. So we shall take the prepared slides of onion root tip for the study of different stages of mitotic cell division. On examining the slides under microscope you will find many cells which are showing different stages of division. These different stages are as follows :

Prophase :

(i) Chromosomes are distinct in the nucleus.

(ii) In some cells, nuclear membrane is disappearing.

(iii) In some cells, the chromosomes are bifurcating into two chromatids.

(iv) In some other cells, two poles are distinctly visible.

(v) In some cells, the chromosomes are connected with the poles with the help of asters or astral rays.

Metaphase :

(i) In some cells, the nuclear membrane has totally disappeared.

(ii) Chromosomes are placed in the middle of the cell horizontally.

(iii) The chromatids of each chromosome separate from each other by dividing the centromere into two parts. Now the independent chromatid is called the chromosome.

(iv) Each newly formed chromosome is connected with the pole of its respective side with the help of astral rays.

Anaphase :

(i) In some cells, the chromosomes start moving towards their pole.

(ii) Chromosomes first of all attain the shape like 'V' then 'J'.

(iii) The empty space gradually increases in between both the groups of chromosomes.

(iv) The chromosomes of each group reach near their respective pole.

Telophase :

(i) In some cells, chromosomes reach near both the poles.

(ii) Astral rays are disappearing in some cells.

(iii) In some cells, nuclear membrane is starting forming around the chromosomes.

(iv) In some cells, grooves start forming in the middle externally which is called the starting of Cytokinesis. (See Fig. 3.4 on page 93)

Cytokinesis :

In animal cell, the constriction appears from external side in the middle of the cell which starts from the late anaphase. It increases interiorly and is completed upto the end of telophase. Thus a cell is divided into two daughter cells.

In plant cell, a lamella is formed in the middle of the cell cytoplasm which is a plate like. It increases in size and divides the whole cell into two daughter cells.

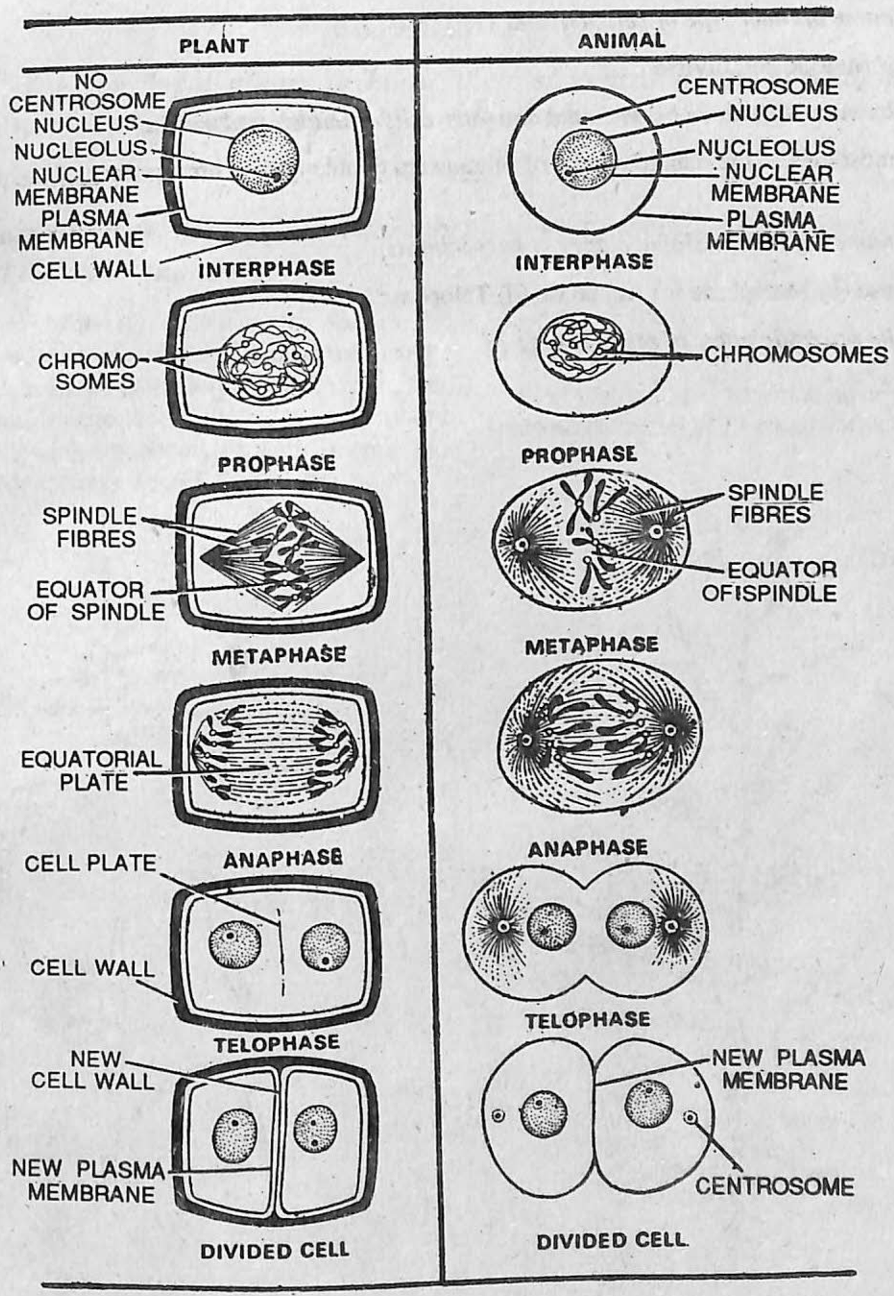


Fig. 3.4 Process of mitosis in plant and animal cells

ORAL QUESTIONS

Q. 1. *What type of cell division do you find in the cells of root tip or stem tip ?*

Ans. Mitotic cell division or Mitosis.

Q. 2. *Give the name of other type of cell division?*

Ans. Meiosis or Meiotic cell division.

Q. 3. *What is the main difference between the daughter cells of mitosis and meiosis ?*

Ans. The chromosomes in the daughter cells of mitosis are double to the chrrmosomes of the daughter cells of meiosis.

Q. 4. *Give the names of the divisional stages of karyokinesis.*

Ans. (a) Prophase (b) Metaphase (c) Anaphase (d) Telophase.

Q. 5. *What is the scientific name of resting stage ?*

Ans. Interphase.

EXPERIMENT 3.5

Study of a few local plants to know their structural features with reference to adaptations xerophytic, mesophytic, hydrophytic habitats.

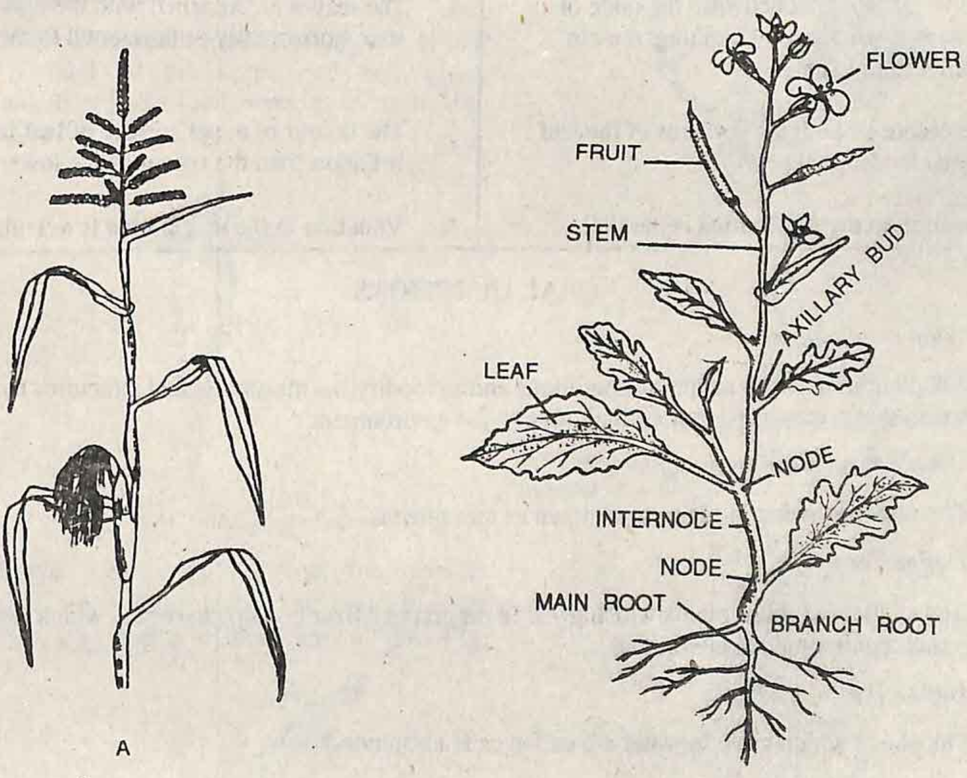
EXPERIMENT 3.5 (A)

Comparison of features of external morphology of locally available monocotyledonous and dicotyledonous plants.

Required Material : Select any one of the following dicotyledonous plant because they can be easily brought in the laboratory—Tulsi, Gram, Pea, Bean, Neem, Mango etc. In the same way any one of the following monocotyledonous plants like Wheat, Barley, Grass, Maize, Sugar-cane etc.

Procedure :

Put both the types of plants near each other and study all the aerial parts comparatively.



Monocot Angiospermic plant

Dicot Angiospermic plant

Fig. 3.5 (A)

Observation :

	Monocotyledonous Plant		Dicotyledonous Plant
1.	Stem is cylindrical, delicate, smooth and green. Nodes and internodes are distinct. Internodes are much elongated.	1.	Stem is green in young stage but becomes brown in the later stage, rough and cylindrical. Nodes and internodes are distinct. Internodes are very near to each other.
2.	Secondary growth does not take place. Therefore, it remains delicate throughout life.	2.	Secondary growth takes place in the stem. So it develops in width age wise and it becomes strong and dark in colour.
3.	The leaves are sessile.	3.	The leaves are petiolated.
4.	The leaves are attached with the node of the stem in such a way that they remain parallel to the Sun-rays.	4.	The leaves are attached with the node of stem horizontally or horizontal to the earth.
5.	The colour of both the surfaces of the leaf lamina is identical.	5.	The colour of upper surface of leaf lamina is darker than the colour of the lower surface.
6.	Venation in the leaf lamina is parallel.	6.	Venation in the leaf lamina is reticulate type.

ORAL QUESTIONS

Q. 1. *What is adaptation ?*

Ans. Adaptation means to adapt the conditions and to modify the morphological structures by organism in such a way that it may survive for a long time in the environment.

Q. 2. *What do you mean by mesophyte ?*

Ans. The plants growing in plains are known as mesophytes.

Q. 3. *Define Xerophyte.*

Ans. Xerophytes are those plants which grow in deserts and bear certain characters which are specially meant for such environmental conditions.

Q. 4. *Define Hydrophytes.*

Ans. The plants which grow in water are called as Hydrophytes.

EXPERIMENT 3.5 (B)

Study of few local mesophytic plants with special reference to the modifications of roots.

Types of Roots :

The roots of all types of plants are mainly divided into two kinds :

Tap Roots : Those roots which arise from the radicle of the germinating seed and remain throughout the life of the plant are called 'Tap roots'.

Modifications of tap root : There are the following modifications of tap roots.

Conical : Such modification of tap root is that which is thick at the upper end and tapers downward. It collects food material in itself, *e.g.* Carrot. [See Fig. 3.5(B).1].

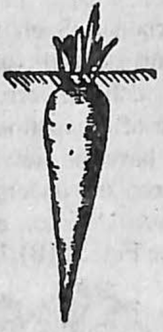


Fig. 3.5(B).1 Conical root of carrot

Fusiform : Such type of roots are spindle shaped *i.e.*, broad in the middle and tapers towards both sides, *e.g.* Radish of cold region. [See Fig. 3.5(B).2].

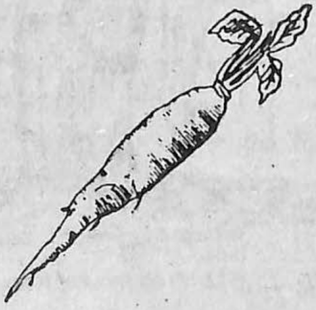


Fig. 3.5(B).2 Fusiform root of Radish

Napiform : Such type of roots are too much thick at the upper end but suddenly becomes thin *e.g.* turnip, sugar beet, etc. [See Fig. 3.5(B).3].

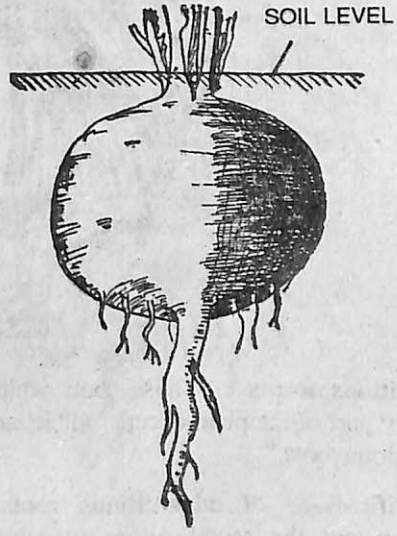


Fig. 3.5(B).3 Napiform root of turnip

Tuberous : Such tap roots become long and become thick at various places in indefinite manner, *e.g.* Gulabans.

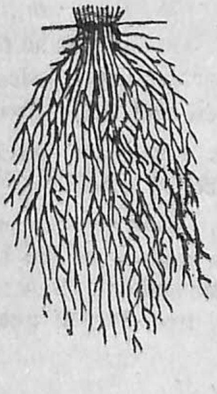


Fig. 3.5(B).4 Adventitious roots (Fibrous roots of Wheat)

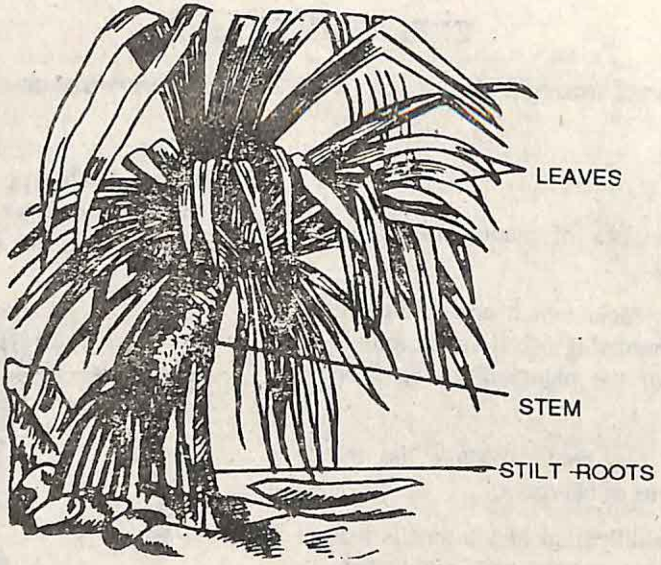


Fig. 3.5(B)5 Stilt roots of Kewara

Adventitious Roots : "Those roots which grow from any part of the plant except radicle, are called adventitious roots."

Modifications of adventitious roots : The following are the modifications of adventitious roots:

Fibrous roots : Such roots arise from the lower part of the plant in the form of fine multicellular threads. These roots enter in the soil and fix the plant and absorb the food material and water for the plant, *e.g.* wheat, barley, grass roots. [See Fig. 3.5(B).4].

Stilt roots : There are some roots which grow from all the sides of lower nodes of stem. They insert in the soil and help in fixing the plant.

For example Sugar cane, Maize, Bajra, Jowar, Kewara, etc. [See Fig. 3.5(B).5].

Prop roots : There are some roots which grow from the lower surface of the heavy and bulky twigs of big trees and help in bearing their weight *e.g.* in Banyan tree, Peepul tree, etc. [See Fig. 3.5(B).6].

Contractile roots : Such type of roots arise from the lower surface of rhizome or corm or bulb. These roots are delicate, erect, long, thick and fleshy. The zone of elongation part is very much developed. They have the power of contraction due to which they keep the underground stems inside the soil with great force, *e.g.* Onion, Garlic, Croncus, etc. [See Fig. 3.5(B).7].

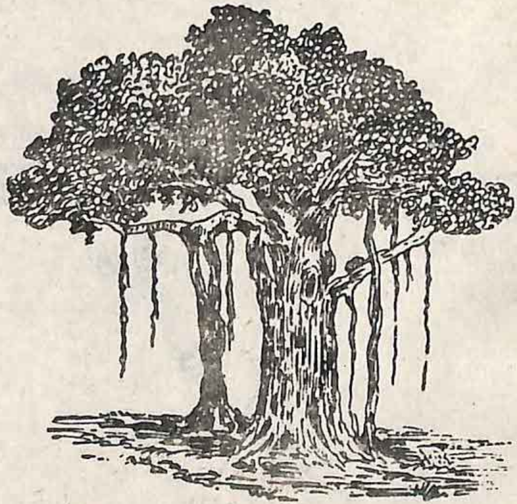


Fig. 3.5(B).6 Prop roots of Banyan tree

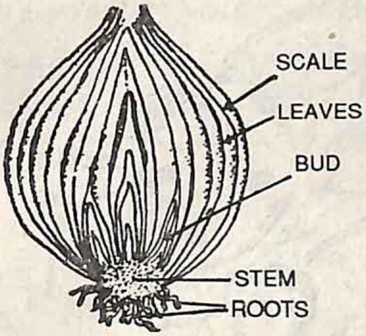


Fig. 3.5(B).7 Onion Bulb with Contractile roots

Nodulated roots : Such modified adventitious roots expand suddenly at various places. The food material is stored in the expanded parts. Bacteria of Bacillus-redicicola type take shelter in the expanded parts. They absorb free atmospheric nitrogen and convert it into nitrates and nitrites. Plants receive these nitrates and nitrites and give shelter and food to the bacteria. Thus they help each other in life. This type of living condition is called '*Symbiosis*', *e.g.* Roots of Groundnut, Gram and other members of the family Leguminocea, Mango, Ginger, Arrowroot, etc. [See Fig. 3.5(B).8].

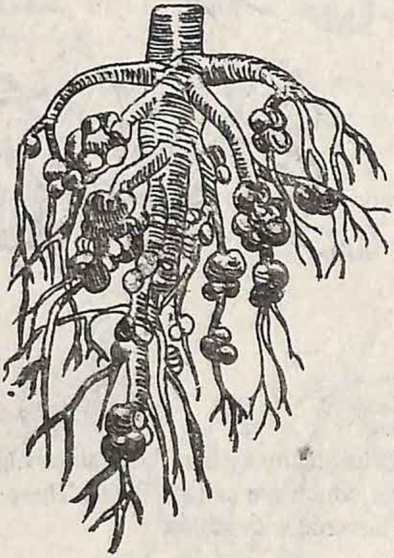


Fig. 3.5(B).8 Nodulated roots of Gram

EXPERIMENT 3.5 (C)

Study of few local mesophytic plants with special reference to the modifications of stems.

STEM

"It is the ascending part of the plant which arises from the plumule of the embryo of seed during germination. It grows towards sunlight."

Morphological characters of stem :

(i) It is green, cauline, thick and branched.

(ii) It provides the space for the fixation of leaves, flowers and fruits.

(iii) It has distinct nodes and internodes.

(iv) It has an apical or terminal bud at its top end.

(v) It has hairs. They are multicellular and are named as stem hairs.

(vi) It always grows towards sunlight *i.e.*, it shows positive heliotropism.

(vii) Mostly it prepares food for the plant in young stage.

(viii) In some cases it stores food for the future of the plant.

Modifications of stem :

A. *Tuber* : (i) It is the modification of underground stem.

(ii) It is indefinite in shape.

(iii) It is thick due to the storage of food material.

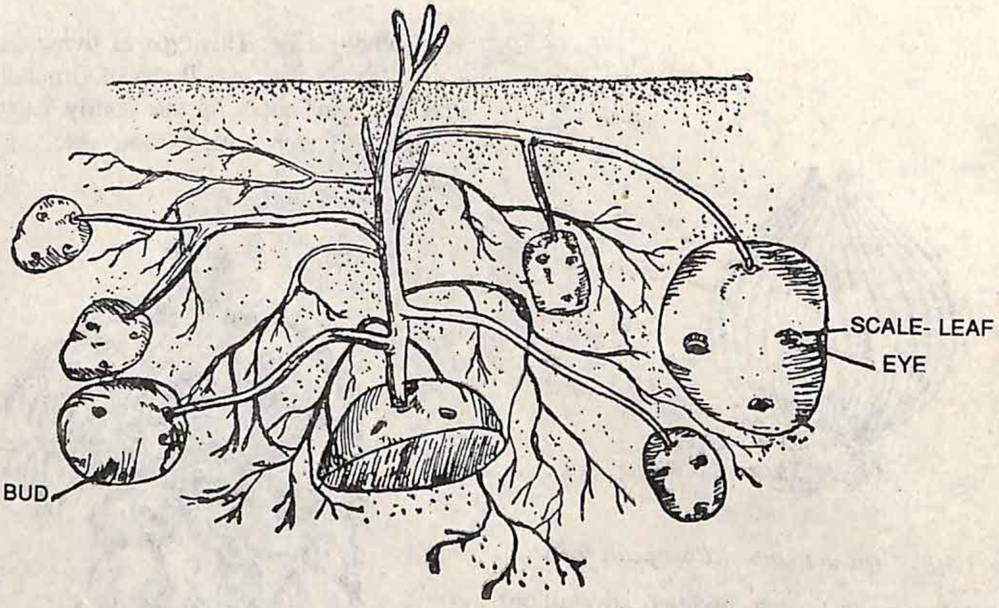


Fig. 3.5(C).1 Tubers of Potato

(iv) It has many axillary buds at various places in the pits which are called 'Eyes'. These axillary buds are covered with scales.

(v) The axillary buds remain in the dormant condition. When the favourable season comes back, these buds become active and give rise to the new plants.

(vi) The distal end has an apical bud.

(vii) It has no adventitious roots. [See Fig. 3.5(C).1].

B. *Rhizome* : (i) It is the type of underground stem.

(ii) It grows parallel to the earth.

(iii) It is devoid of chlorophyll. It is mostly light or dark brown.

(iv) It is thick due to the storage of food material.

(v) It has distinct nodes and internodes.

(vi) Many axillary buds and terminal buds are found on the node which are covered by scaly leaves.

(vii) These axillary buds give rise to new stems in the forth coming favourable environmental conditions.

(viii) Many small adventitious roots come out from the lower part of each node which enter in the soil.

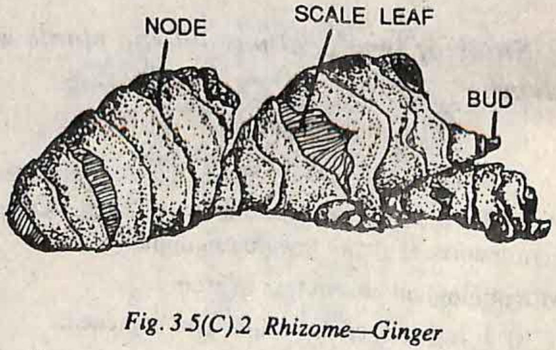


Fig. 3.5(C).2 Rhizome—Ginger

(ix) The terminal bud also develops in the favourable condition which gives rise to false aerial stem, *e.g.*, Turmeric, Canna, Fern, Ginger, Banana, etc. [See Fig. 3.5(C).2]

C. *Corm* : (i) It is also the type of underground stem.

(ii) It grows vertical to the earth.

(iii) It is thick due to the storage of food.

(iv) It has distinct nodes and internodes.

(v) It has many axillary buds and apical bud.

(vi) It has scaly leaves on the nodes.

e.g., Jimikand, Kesar, Kachalu, Fresia, Amorphophallus (Kanda), Saffron, etc. [See Fig. 3.5(C).3].

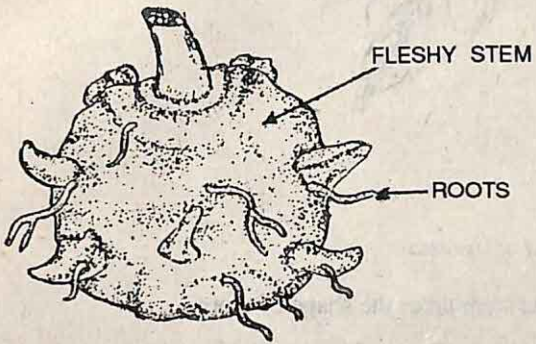


Fig. 3.5(C).3 Corm of Amorphophallus

D. *Bulb* : (i) It is the modification of underground stem.

(ii) Its stem part is thick but short in length which is flat at the base and convex at the top.

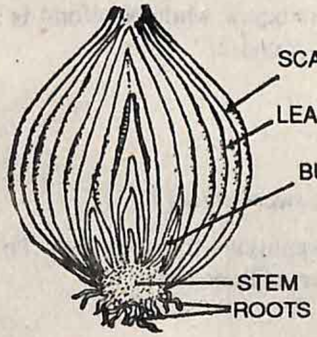


Fig. 3.5(C).4 Bulb

(iii) Many contractile adventitious roots arise from the base which fix the whole plant in the soil and also absorb the food material and water in the form of solution for the plant.

(iv) The whole stem is covered with succulent scaly leaves.

(v) The outer most leaf is thin, dry and pink which is called, 'tunic'. It forms the covering of the bulb. [See Fig. 3.5(C).3], *e.g.*, Onion, Garlic, Lily, Tulip, etc.

E. *Stolon* : (i) It is also a modification of underground stem.

(ii) It grows inside the earth in the form of branches. These branches are long and thin and develop in all the directions.

(iii) The distal end of these branches comes out from the soil and develops in the form of a new plant.

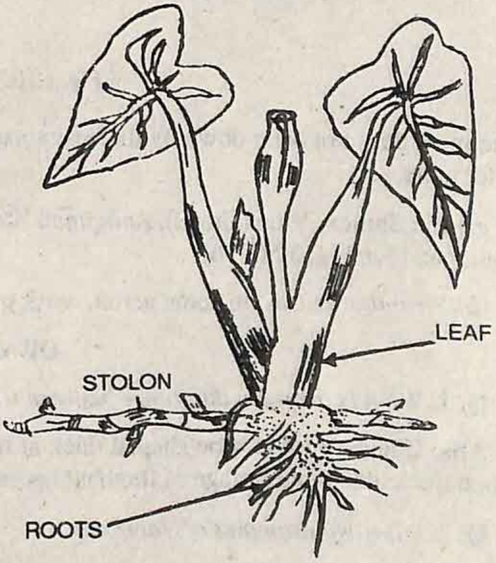


Fig. 3.5(C).5 Stolon

(iv) The nodes of underground part are covered with the scales.

e.g., Colocasia, Ixora, Passiflora, Chameli, Bela, Kachu, Arkha, Sandal rose, Arrow root, Dracaena, etc.

F. *Stem tendrils* : (i) It is the modification of weak, aerial plants.

(ii) Stem and its branches are modified into tendrils which help in raising up the weak plant.

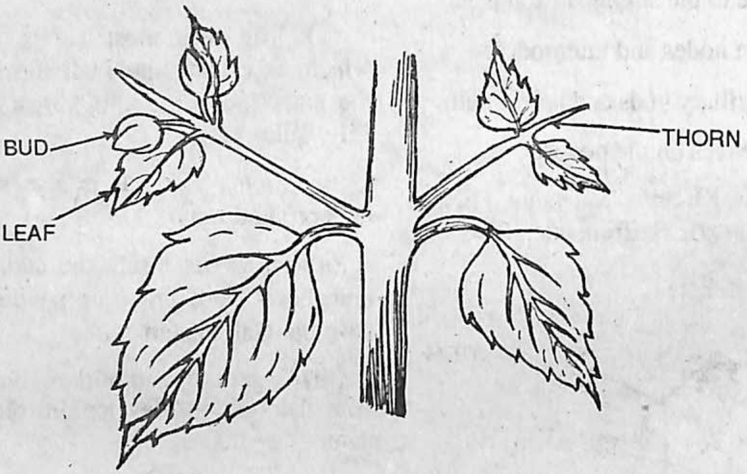


Fig. 3.5(C).6 Thorns of Duranta

The plant does not bend down by the heavy load of other parts.

e.g., In Smilex, Vine (Grape), *Antigonon* Karela, Loki, etc. [See Fig. 3.5(C).6].

(b) Stem thorns : (i) In some aerial, weak plants the stem takes the shape of thorn.

(ii) These thorns help in climbing on the substratum.

e.g., In rose, *Duranta*, Bougainvillia, Lemon, Orange, Pomegranate, etc. [See Fig. 3.5(C).7].

ORAL QUESTIONS

Q. 1. *What is the main difference between Conical and Napiform ?*

Ans. Conical root is cone shaped thick at the upper part and tapers below while Napiform is also too much thick due to the storage of food but becomes very thin at the lower end.

Q. 2. *Give two examples of Napiform.*

Ans. Turnip and Beet root.

Q. 3. *What is the main point of difference between a potato and the sweet potato ?*

Ans. Potato is the underground stem while sweet potato is adventitious tuberous root. Potato has axillary buds known as eyes of potato while sweet potato does not have axillary buds.

Q. 4. *What type of roots you find in onion ?*

Ans. Contractile adventitious roots.

Q. 5. *Give the example of phylloclade ?*

Ans. Opuntia.

Q. 6. *Give one example of phyllode ?*

Ans. Australian acacia.

Q. 7. *What is a tendril ?*

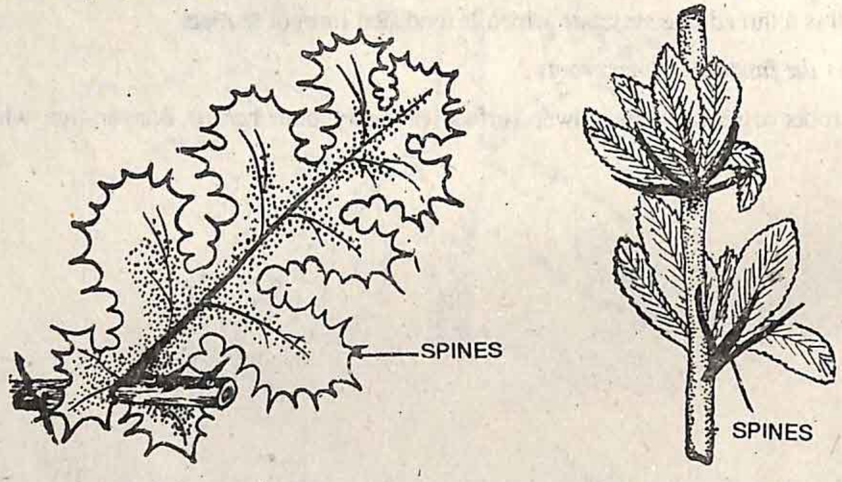
Ans. Tendril is a thread like structure which is modified form of leaflets.

Q. 8. *What is the function of prop roots ?*

Ans. Prop roots arise from the lower surface of bulky branches of Banyan-tree which act as the support.

EXPERIMENT 3.5 (D)

Study of few Xerophytic plants with special reference to some modifications.



(a) Prckly Poppy—Leaf Spines *(b) Baberry—Leaf Spines*

Fig. 3.5(D).1

A. *Leaf Spine* : In some plants the leaf wholly or partly is modified into spines which protect the plant and decreases the rate of transpiration, *e.g.*, in Barbaris the whole leaf is converted into spines. Some branches of spur from the axillary buds come out in bunches.

In Opuntia, first leaves degenerate and then the leaves of second time convert into spines.

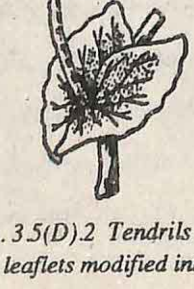


Fig. 3.5(D).2 Tendrils of Pea
(Upper leaflets modified into tendrils)

In Argemone the edges of the leaf are converted into spines.

B. *Leaf tendrils* : In some plants the whole leaf or some of its leaflets are converted into tendrils which help to the plant in climbing, *e.g.* in wild pea (Lathyrus odoratus) the whole leaf is modified into tendril but in the flowering pea (Pisum sativum) [See Fig. 3.5(D).2] only some leaflets of the compound leaf are converted into tendrils.

In the case of kaliyari the apex of the leaf is converted into tendril.

e.g. Gloriosa, Antigonon, etc.

Phylloclade : (i) It is the modification of stem in Xerophytic plants.

(ii) In such plants, the stem is thick and flat due to the storage of food material.

(iii) The stem becomes green like a leaf which helps in the preparation of food during photosynthesis.

(iv) The leaves are modified into spines so that the water may evaporate in less quantity.

(v) Nodes and internodes are not very distinct.

e.g. Prickly pear (Opuntia), Ruscus, Malenvekia, Asparagus. [See Fig. 3.5(D).3].

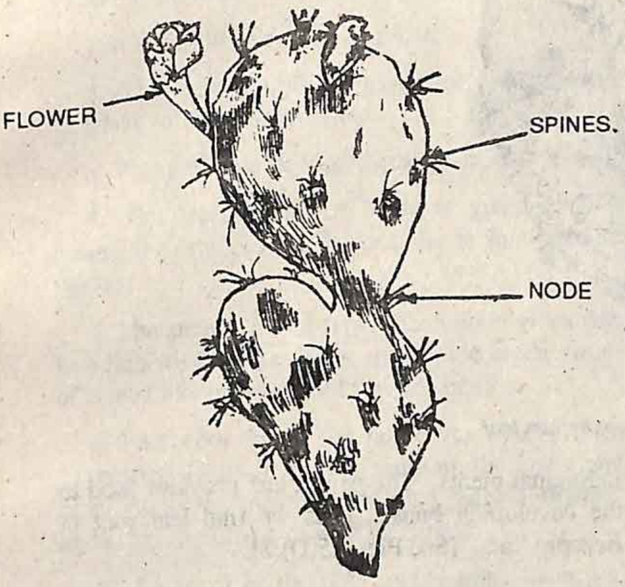


Fig. 3.5(D).3 Phylloclade of Prickly Pear (Opuntia)

Phyllode : (i) It is the modification of leaf in the Xerophytic plants.

(ii) The petiole or any part of the rachis becomes swallen and flattened and attains the shape like a thick green leaf.

(iii) This thick, green and flattened part is known as phyllode.

(iv) The true leaf is pinnately compound.

(v) The leaf-lets are green and very small in size which in young stage or later fall off.

(vi) The phyllode then does all the functions of leaf.

(vii) The phyllode generally arises vertically to the sun rays. This position of it reduces the evaporation of water.

e.g. All species of Australian Acacia (Keekar). [See Fig. 3.5(D).4].

C. *Succulent leaf* : In some plants the leaf becomes thick, green and fleshy and has the power to take part in asexual reproduction.

For example in Bryophyllum, the leaf is green, fleshy and rough on both the surfaces.

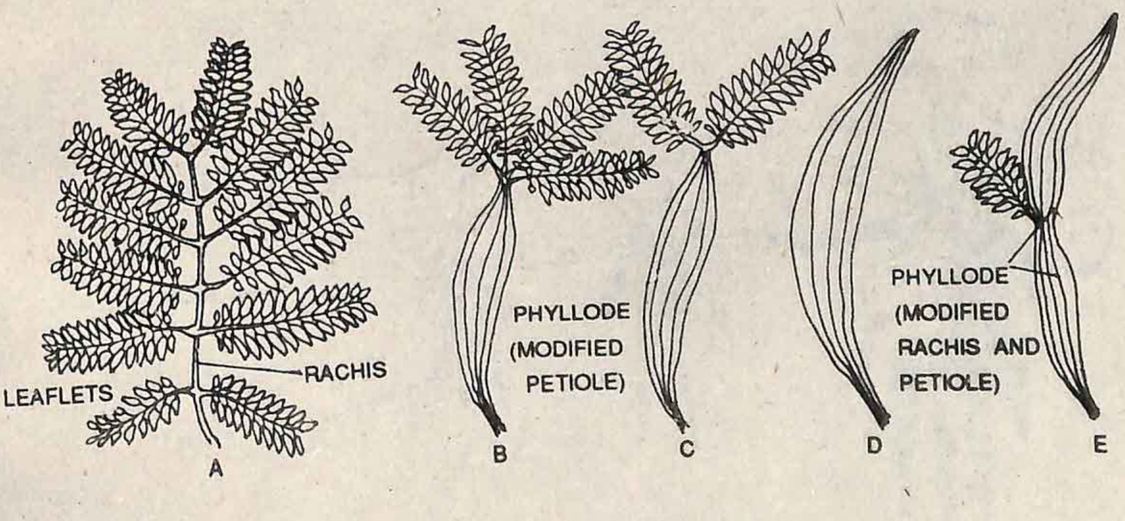


Fig. 3.5(D).4 Development of Phyllode in Australian Acacia

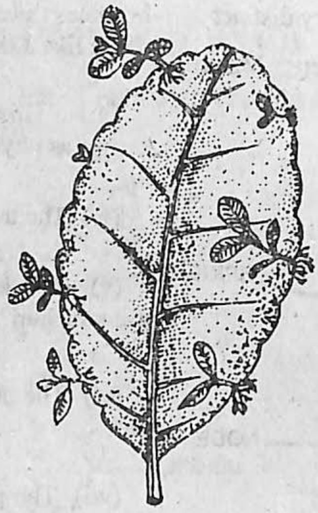


Fig. 3.5(D).5 Bryophyllum leaf

It has the axillary buds in the axil of the edges which on maturation, germinate and give rise to individual plants. The parent leaf provides food to the developing buds. Thus we find leaf root in Bryophyllum. [See Fig. 3.5(D).5].

EXPERIMENT 3.5 (E)

Study of few hydrophytic plants with special reference to some modification.

Water Hyacinth

1. It is simple hydrophytic plant.

2. The leaf petiole is expanded and hollow which is called petiolate float.

3. This petiolate float helps the plant in floating.

4. The leaf lamina or blade is green and is arranged as the crown. It does all the functions of the leaf.

5. The stem is offset type. Each node gives rise to a bunch of leaves on the upper side and a group of thread like roots towards the lower side.

6. Each root thread has numerous small fibers. These root fibers help in sucking up the water and other dissolved material and also help in floating and attaching the plant with substratum.

7. If a piece of the plant is separated from the rest of the plant, it develops swiftly and covers the whole upper surface of water. Water is not visible easily.

e.g., Water *Hyacinth plant* (Jal Kumbhi). [See Fig. 3.5(E).1].

Insectivorous plant :

There are some plants which take in insects as their food. Such plants are called insectivorous plants. Following are some insectivorous plants :

Pitcher plant (Nepenthes) :

It is an Insectivorous plant. Its leaves are

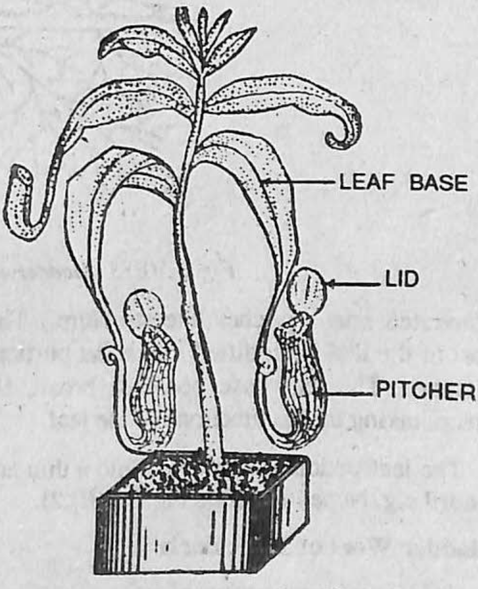


Fig. 3.5(E).2 Pitcher Plant (Nepenthes)

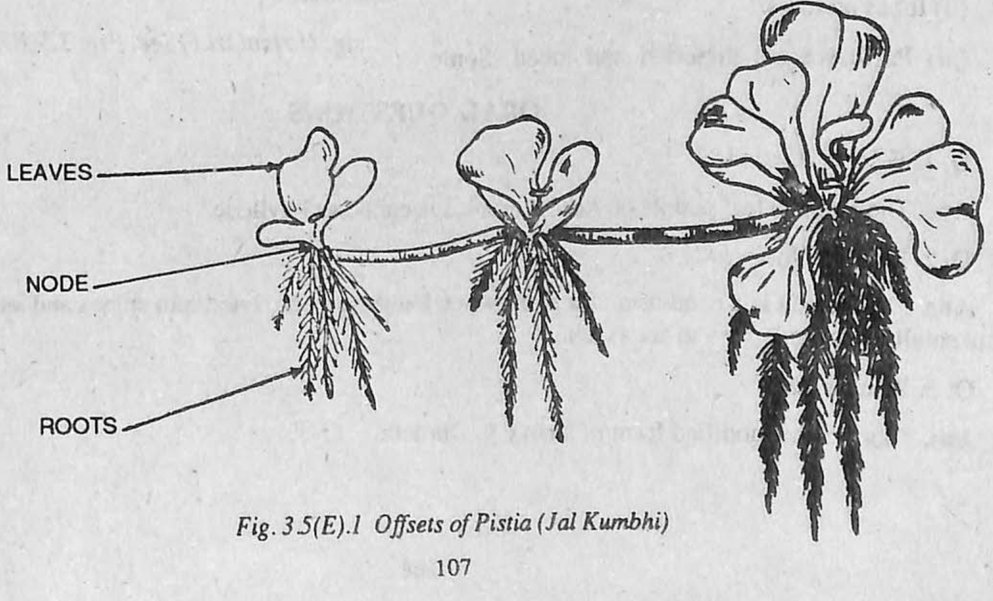


Fig. 3.5(E).1 Offsets of Pistia (Jal Kumbhi)

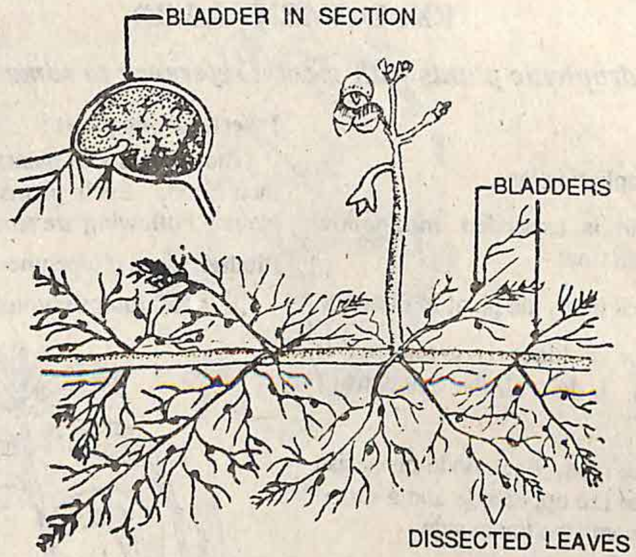


Fig. 3.5(E).3 Bladderwort (Utricularia) with many small bladders

converted into a pitcher like structure. The apex part of the leaf is modified into a flat portion like a pitcher. The leaf base becomes broad, flat and green, taking up the functions of the leaf.

The leaf petiole is converted into a thin and long tendril e.g. Nepenthes [See Fig. 3.5(E).2].

Bladder Wort or Utricularia :

(i) It is an insectivorous plant.

(ii) It has no roots.

(iii) Its leaves are dissected and lobed. Some lobes are converted into bladders.

(iv) Each bladder has one trap door which opens towards inside and then closes up.

(v) There are several digestive glands at the inner surface of each bladder which secrete the digestive juice.

(vi) It is generally found in the stagnant and shallow water or in damp soil in a semi floating condition.

e.g. Utricularia [See. Fig. 3.5(E).3].

ORAL QUESTIONS

Q. 1. *What is Phyllode ?*

Ans. The bulbous leaf petiole of Acacia arabica is called as Phyllode.

Q. 2. *What is Phylloclade ?*

Ans. Phylloclade is a condition of a plant when leaves are converted into spines and stem is converted into smaller, flat and green to act as leaf.

Q. 3. *What is thorn ?*

Ans. Thorn is the modified form of stem e.g. Duranta.

Q. 4. *What is spine ?*

Ans. Spine is the modified form of leaf *e.g.* In Barberry.

Q. 5. *What is the Property of Bryophyllum ?*

Ans. Bryophyllum leaf is flat, broad, thick and with rough surface having axillary buds at the axils of leaf margins. These axillary buds during favourable conditions grow and give rise to new individual plant.

Q. 6. *Why is utricularia called as an insectivorous plant ?*

Ans. Utricularia has bladder shaped structures with the help of which it catches insects and utilizes them as food.

EXPERIMENT 3.6

Study of a few local animals to know their structural adaptations in respect of their terrestrial (cockroach), aquatic (Fish, Prawn), amphibious (Toad, Frog, Snail, Octopus), aerial (Bird) and burrowing (Earthworm Rat, Snake) habitats.

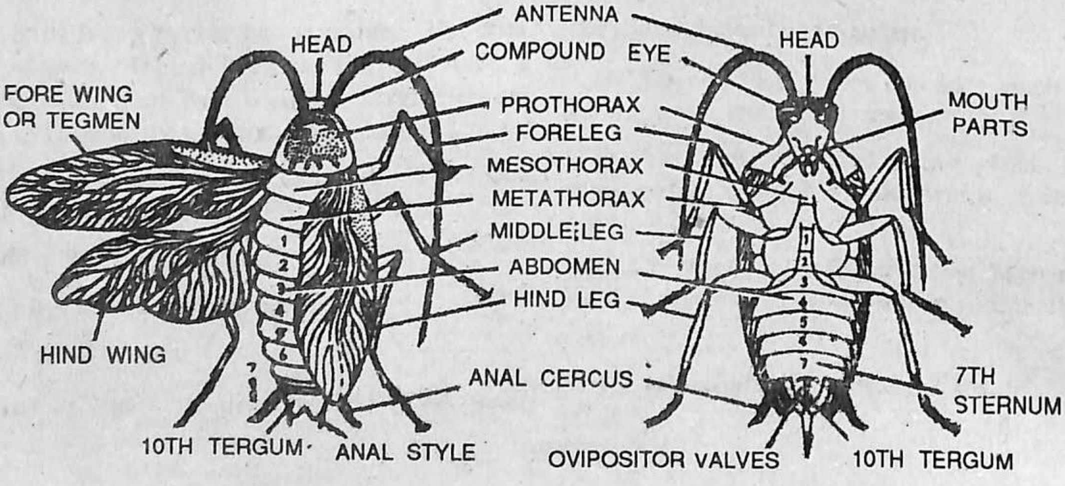
Though all animals have certain characters on the basis of which they are classified into groups. These animals are also classified on the basis of their habitats into the following main categories : (1) Terrestrial, (2) Aquatic, (3) Amphibious, (4) Aerial and (5) Burrowing.

TERRESTRIAL HABITAT :

The animals, living on earth, are called as terrestrial animals. All animals have certain similar characters but they differ on their mode of living and feeding. Their body structures are also suited for their environmental conditions and mode of feeding so that they may live easily and comfortably. Only cockroach is explained here as an example to know the structural adaptations in respect of its terrestrial habitat.

1. COCKROACH (Periplaneta americana)

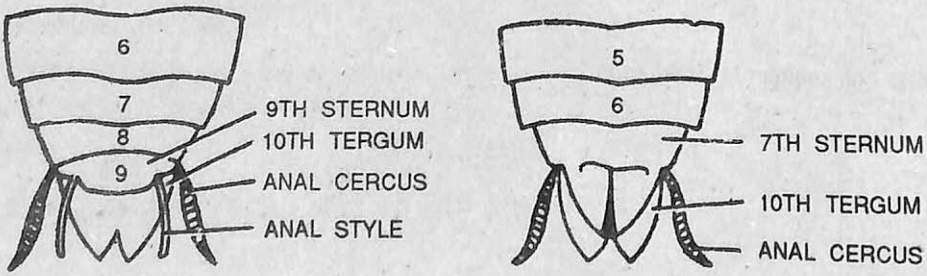
Kingdom	Animalia.
Division	Nonchordata.
Subkingdom	Metazoa.
Phylum	Arthropoda.
Class	Insecta.
Type	Cockroach.



A. Dorsal view

B. Ventral view

Fig. 3.6.1 External features of Cockroach



MALE

FEMALE

Fig. 3.6.2 Posterior part of abdomen showing differences in male and female cockroach

Terrestrial adaptations in Cockroach :

1. Cockroach is dark brown in colour which is most suited to its environment as it lives in dark and moist places like sewer pipe lines, gutter, dark moist places of book shelf, kitchen, bakeries, godowns, stores etc.

2. It is nocturnal in nature and avoids daylight.

3. It is dorsi-ventrally flattened which is about 40 millimetres long and about 12 millimetres broad. The whole body is covered over by chitinous pieces forming Exo-skeleton. The piece of dorsal surface is called Terga (Singluar-Tergum) while the piece of ventral surface is called Sterna (Singular-Sternum).

4. The whole body is divided into head, thorax and abdomen.

5. Head is small in size bearing a pair of compound eyes, mouth and mouth parts.

6. Mouth parts include, labrum, mandibles, first maxillae and hypopharynx which are arranged in such a manner that they can easily cut and chew the bread, paper and other big and delicate food stuffs into small pieces.

7. There is a pair of antennae which are very sensitive to touch and help to identify the good or bad, smell etc.

8. The thorax is the middle part of the body which is anteriorly connected to the head with the help of a small neck.

9. The thorax is transversely divided into prothorax, mesothorax and metathorax.

10. There are three pairs of jointed legs. Each pair of legs are attached with each part of thorax ventrally which help in walking.

11. There are two pairs of wings attached with meso and meta thorax dorsally. These wings help in flying.

12. The abdomen is divided into ten segments.

13. The tenth segment has a pair of Anal cerci both in male and female.

14. The male cockroach has an additional pair of anal styles which help in copulation.

ORAL QUESTIONS

Q. 1. *Write the zoological name of Cockroach.*

Ans. Periplanata americana.

Q. 2. *What do you mean by compound eye ?*

Ans. The eye has several sections. Each section is responsible to receive the photo of that part of the object which comes infront of it. All the sections send their messages to the optic lobes and thus the animal realizes the appearance of the object.

Q. 3. *What is the main difference between anal cerci and anal styles ?*

Ans. Anal cerci are two in number present in male and female body of cockroach. While anal styles are also two in addition in male body which help in copulation.

AQUATIC HABITAT

No doubt, all the hydrozoa have some similarities in their structure, mode of feeding and mode of living conditions even then they have some dissimilarities from others. Some hydrozoa which are found in fresh water, are called as aquatic animals while those which are found in salty water, are called as Marine animals. Both aquatic and marine animals are further classified into three categories on the basis of their swimming conditions in water.

1. Plankton, 2. Necton and 3. Dwellers.

Planktons float on the upper surface of water. They can tolerate the atmospheric pressure and can live in bright sunlight.

Nectons float in the middle of water. They can tolerate the atmospheric and some water pressure and can resist in dim sunlight.

Dwellers can bear the atmospheric and water pressure but can not tolerate the sunlight.

Some structural adaptations in fish and prawn are studied here.

2. FISH

Kingdom	Animalia.
Phylum	Chordata.
Subkingdom	Vertebrata.
Super class	Pisces.
Class	Teliostomi.
Type	Labeo (Rohu).

Characters :

(i) Labeo (Rohu) is the fresh water fish or Aquatic fish.

(ii) Body is delicate and is covered with scales.

(iii) Body is divided into head, trunk and tail.

(iv) It possesses dorsal unpaired fins, lateral fins, tail fin, pelvic fin and pectoral fins which all help in locomotion.

(v) Tail also helps in locomotion and changing the direction.

(vi) Respiration takes place through gills which are 5-7 pairs and are situated laterally on either side of the head region.

(vii) It lays eggs in the water. The development of young ones from eggs takes place in water.

(viii) Body colour is silvery white on lateral surface while steel grey dorsally. Due to such body colour it is not recognised easily by its enemies and prey too.

(ix) Scales are made of dead cells due to the presence of which the body remains safe from external effect.

(x) Scales glitter in various shining colours which attract small insects towards it and thus help in feeding.

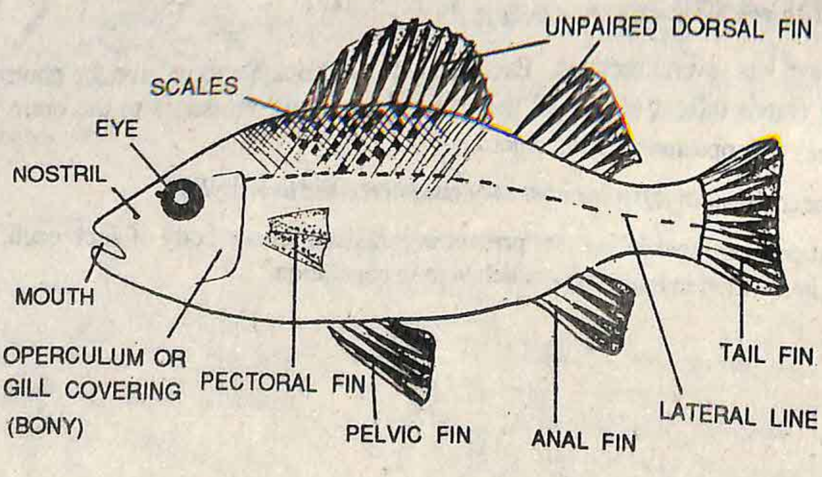


Fig. 3.6.3 Bony Fish—External features

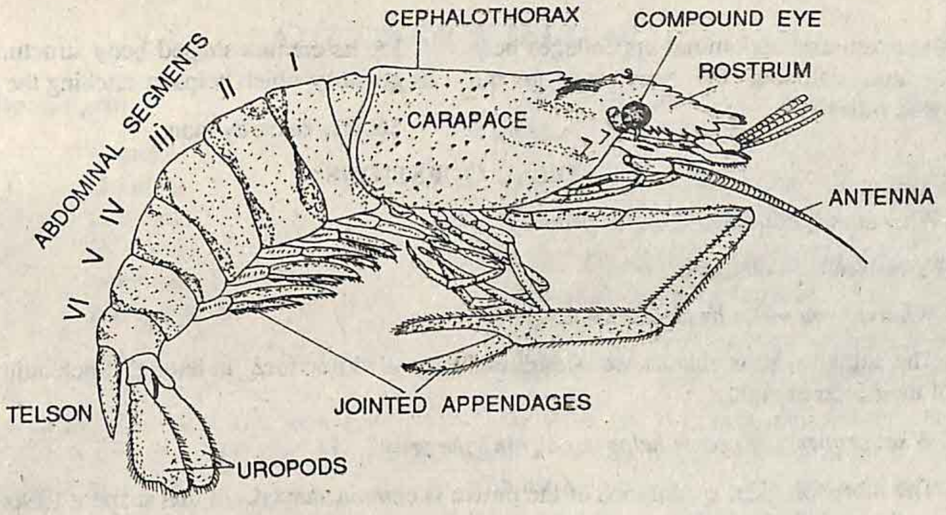


Fig. 3.6.4 Prawn—External features

3. PRAWN (Palaemon malcolmsoni)

Classification :

Phylum	Arthropoda.
Class	Crustacea
Subclass	Malacostraca
Type	Palaemon (Prawn).

Morphological characters with adaptations :

1. Prawn is found in fresh water streams, lakes, ponds and rivers.

2. Its body is about 25 cms. long, spindle shaped and bilaterally symmetrical.

3. Its body colour is deep orange.

4. The whole body is divided into cephalothorax, abdomen and telson.

5. The whole body is divided into 19 segments out of which first 13 segments form cephalothorax. Cephalothorax is a jointed body part of head and thorax. First to fifth segments are of head region and 6th to 13th segments are of thorax region. All the 13 segments are covered externally with a hard covering known as Carapace of which anterior part is narrow saw shaped and is called as Rostrum.

6. There is a pair of distinct eyes in the head region.

7. The abdomen consists of six segments which are semi-circular dorsally and compressed laterally. These abdominal segments are normally bent under the cephalothorax. Therefore the whole body looks like a 'Comma'.

8. Telson is a small pointed tail situated at the posterior end of the body attached with the 6th abdominal segment.

9. It has 19 pairs of appendages or jointed legs, one pair in each segment situated ventrally.

10. The cephalic appendages and thoracic appendages are comparatively longer than the abdominal appendages.

11. There is one pair of small chinese fan shaped structures known as Uropods which are situated just below the telson.

12. It is nocturnal in nature. So it dwells at the bottom during the day and comes on the upper surface of water at night in search of food.

13. Its body colour and structure gives the idea of a piece of stone to the other animals, which help in saving its life.

14. Its rostrum and abdominal appendages help in tearing and catching the prey and in the movement in water.

15. Its comma shaped body structure represents its gentility which helps in catching the prey.

16. It is eaten by man.

ORAL QUESTIONS

Q. 1. *What is the zoological name of prawn ?*

Ans. Palaemon malcolmsoni.

Q. 2. *What do you mean by nocturnal nature ?*

Ans. The animal who is able to see in dark night is called nocturnal in nature. Such animals move in search of their food in night.

Q. 3. *What property of prawn helps in catching the prey ?*

Ans. The morphological appearance of the prawn is comma shaped. In this shape it looks very gentle. As soon as the prey comes near to it, it hunts.

Q. 4. *Fish lives in water throughout its life even its body does not rot. Why ?*

Ans. The whole body of fish is externally covered by scales which are made up of dead cells and are uneffective to water.

Q. 5. *What is cephalothorax ?*

Ans. Cephalothorax is the jointed part of head and thorax, *e.g.* in prawn.

AMPHIBIOUS HABITAT

4. FROG (Rana tigrina)

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Super class	Tetrapoda
Class	Amphibia
Type	Rana tigrina

Characters :

(i) Frog is amphibious in nature as it lives on earth as well as in water. Its body is suited for such adaptation in the following way :

(ii) Its whole body is divided into head and trunk while neck is absent.

(iii) Body covered by slimy loosely attached spotted skin which has the property to change the colour according to the colour of the environment.

(iv) The colour of its ventral surface is white while grey dorsally which helps in saving its life from enemies.

(v) Head is triangular which helps in moving in the water.

(vi) Triangular head helps in the floating condition.

(vii) Forelimb is shorter than the hindlimb which helps in jumping on earth.

(viii) All the fingers in the hindlimb are interconnected with the footweb.

(ix) It is carnivorous. Its bifercated, muscular and slimy tongue helps in catching the prey.

(x) Eyes are one pair, situated on the dorsal surface of the head region protruded externally with the help of which it can see in all directions at a time even in the absence of neck.

Toad (Buffo malanostinctus)

Though Toad is similar to Rana tigrina (frog) in structure but have the following variations due to adaptations.

1. The skin is rough and dry having poison glands or parotid glands on the dorsal surface along with numerous warts. The hunting animals do not hunt it due to bad taste and poison.

2. The webs are absent in the fingers because it does not swim in water like frog.

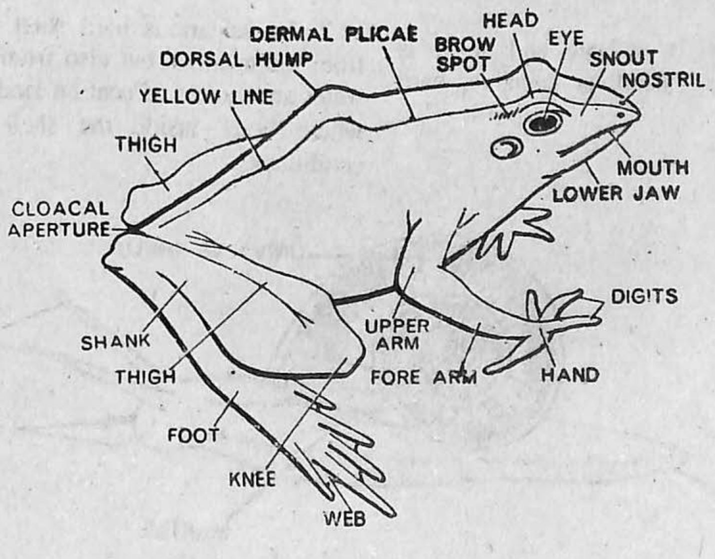


Fig. 3.6.5 Side view of frog showing external features

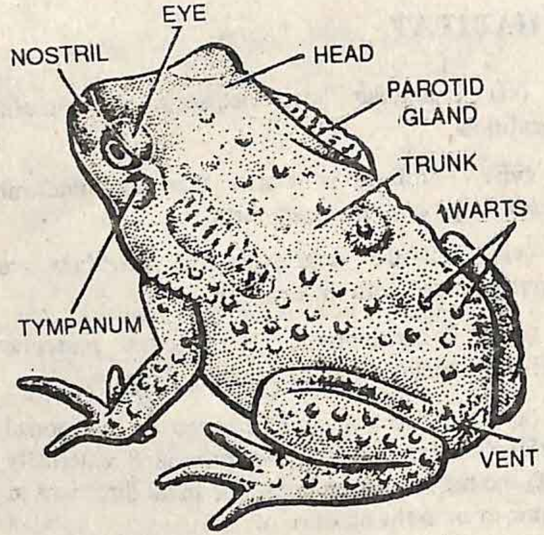


Fig. 3.6.6 External view of toad

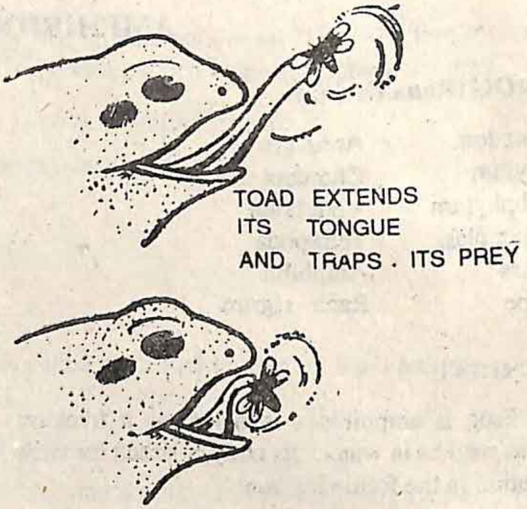

TOAD EXTENDS ITS TONGUE AND TRAPS . ITS PREY

Fig. 3.6.7 Food capture by toad

5. SNAIL (Limnaca)

Kingdom	Animalia
Division	Nonchordata
Subkingdom	Metazoa
Phylum	Mollusca
Class	Gastropoda
Type	Snail (Limnaea)

1. It is generally found in ponds but is amphibious in nature.

2. Its whole body is delicate and so it is externally covered by calcarious univalve, hard shell.

3. The apex of the shell is small and narrow while the open part is broad and is covered over by operculum.

4. It moves with the help of flat, broad and muscular foot which is rounded and moves behind.

5. It is carnivorous and catches its prey with the help of tentacles. The tentacles are flattened.

6. It is unisexual.

7. Its calcarious hard shell not only protects from the enemies but also from adverse effect of water and excess of heat on land. It withdraws its whole body inside the shell in unfavourable conditions.

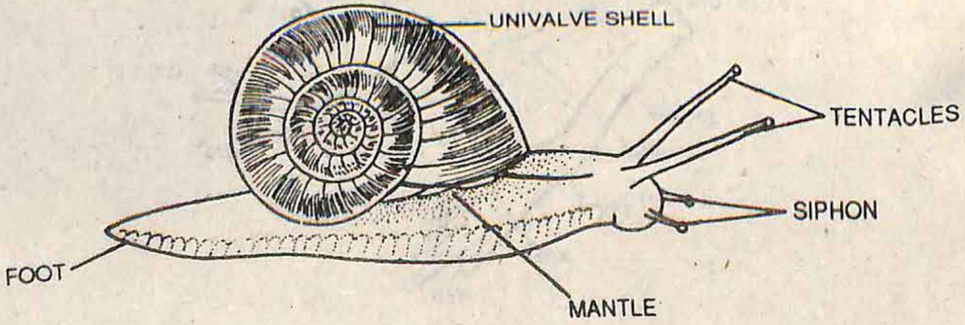


Fig. 3.6.8 Snail

ORAL QUESTIONS

Q. 1. *What is nictitating membrane ?*

Ans. It is the third eye lid situated outside the lower eyelid. It is transparent and flexible which protects the eye from unfavourable conditions.

Q. 2. *What is cloaca ?*

Ans. Cloaca is an aperture situated at the posterior or end part of the trunk through which faces, urine, and genital gametes are expelled from the body.

Q. 3. *How does the frog move on earth ?*

Ans. The fore limbs are shorter than the hind limbs. The hind limbs are 'Z' shaped. It moves on earth by jumping.

Q. 4. *How does the frog catch the prey ?*

Ans. Frog catches its prey with the help of its forked tongue which is free posteriorly while jointed anteriorly.

Q. 5. *How does the frog save its life from enemy ?*

Ans. Frog has the property to change its skin colour according to the environment which saves its life from the enemy.

Q. 6. *What is the importance of shell to the snail ?*

Ans. The calcarious shell is the outer covering of the snail which protects its life from the enemy. It also protects its life from the adverse climatic effects.

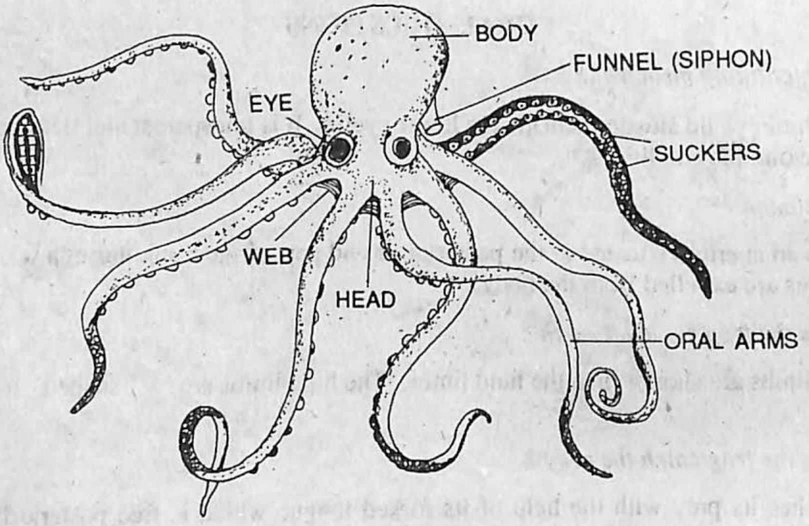


Fig. 3.6.9 Octopus—External Features

6. OCTOPUS

Kingdom	Animalia
Division	Nonchordata
Subkingdom	Metazoa
Phylum	Mollusca
Class	Cephalopoda
Type	Octopus

Adaptive characters :

Octopus is the member of Phylum Mollusca having the following adaptive characters.

1. Its body is very large and can engulf a whole man. Though it is giant in size but is without any shell.

2. It is carnivorous. Feeds on crabs, fishes and other molluscs so it is comonly called as 'devil fish'.

3. Its whole body is divided into head and body.

4. Head bears a mouth in the centre, a pair of stalked eyes and eight arms which are similar to each other.

5. Each arm is webbed, elongated and having suckers or sucktorial pits.

6. These arms are used in crawling, escaping from the enemies and catching the prey.

7. It is nocturnal in nature. It generally crawls at the bottom of the sea.

8. The whole visceral mass and visceral cavity are enclosed by mantle.

9. Its body is spherical having an ink gland inside. Whenever its enemy chases, it ejects inky fluid in the water which makes smoky clouds in the water before the enemy. In the mean time it escapes from there.

ORAL QUESTIONS

Q. 1. *What is the common name of Octopus ?*

Ans. Devil fish.

Q. 2. *How does it escape from the enemy ?*

Ans. There is an ink gland in the body of Octopus. When any enemy chases, it oozes out ink in water which makes clouds in the water before the enemy. In the mean time it changes its direction. Thus it escapes from there.

Q. 3. *When does it catch prey ?*

Ans. It is nocturnal in nature. It catches its prey in the night.

Q. 4. *How many arms are there in the body of Octopus ?*

Ans. There are eight arms in the body of Octopus.

AERIAL HABITAT

7. PIGEON (Columba livia)

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Class	Aves
Type	Columba livia (Pigeon)

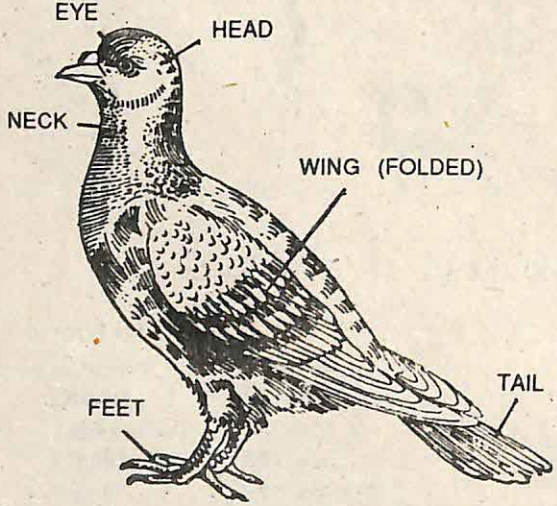


Fig. 3.6.10 A Pigeon—External Features

Characters :

(i) Pigeon is the member of class Aves.

(ii) The whole body is covered by feathers except hind limbs which are covered by scales.

(iii) Mouth along with both jaws are modified into toothless horny beak with pointed tip.

(iv) Forelimbs are modified into wings which help in flight in the air.

(v) The hind limbs have four digits in each. Three of them are directed forward while the fourth one is backward.

(vi) Claws are short and straight but can bend during perching.

(vii) Tail is short and is covered with long feathers.

(viii) All the bones are hollow and light in weight.

(ix) It is unisexual. The female lays eggs.

(x) Thorax region has sternum with keel which help in flight.

ORAL QUESTIONS

Q. 1. *What is the Zoological name of Pigeon ?*

Ans. Columba livia.

Q. 2. *Where are the external nostrils situated ?*

Ans. External nostrils are situated on the dorsal surface at the junction of beak and head.

Q. 3. *The pigeon sits on the electrical wire but it does not feel any shock. Why ?*

Ans. The whole hind limbs are covered by scales, the dead cells which are nonconductor of electricity. That is why the Pigeon does not feel any shock.

Q. 4. *What are the main characters which help in flight ?*

Ans. (a) The pigeon bones are hollow and light in weight which help in flight.

(b) The forelimbs are modified into wings which also help in flight.

BURROWING HABITAT

8. EARTHWORM (Pheretima posthuma)

Kingdom	Animalia
Division	Nonchordata
Subkingdom	Metazoa
Phylum	Annelida
Class	Chaetopoda
Type	Pheretima posthuma (Earthworm)

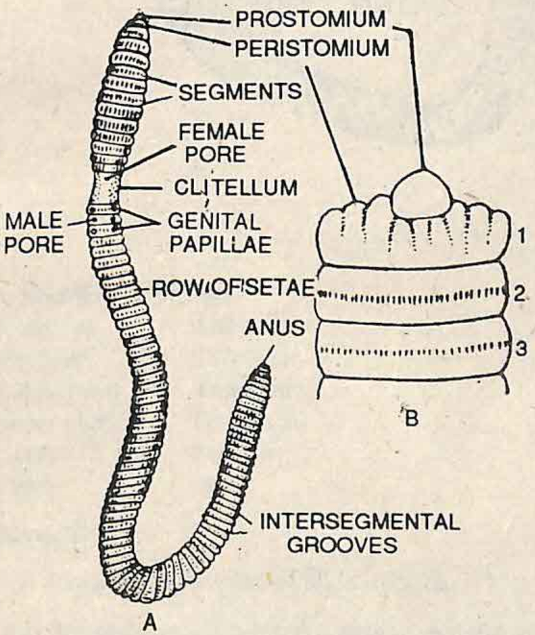


Fig. 3.6.11
Earthworm—External Morphology

Characters :

1. Earthworm is the member of Phylum Annelida.

2. Its body is long cylindrical, slimy and flexible. It can enter in the burrow easily.

3. Mouth is present at one end and anus on the other end. Mouth has a protruded structure just above or dorsal to the mouth which is called as Proboscis. It helps in piercing the mouth in the damp soil to make burrow.

4. It takes the soil in the form of its food which also helps in making burrow.

5. It keeps itself safe in the burrow.

6. It does not have any limb for locomotion. The absence of forelimbs is also in favour of its burrowing habit. It moves by creeping. 'Setae', which are chitinous elongated 'S' shaped structures, help in locomotion. Setae are many in number which are situated at the inter segmental walls.

7. It is hermaphrodite but sexual reproduction occurs in between two members.

8. 14th, 15th and 16th segments are dark brown in colour and are modified into special shape which can be identified from other segments. This special shape is called clitellum which possesses a female reproductive opening in the 14th segment. Fertilization of eggs takes place outside the body but inside the copulatory belt formed just above the clitellum at the time of mating.

ORAL QUESTIONS

Q. 1. *In which segments clitellum lies in earthworm ?*

Ans. In the 14th, 15th & 16th segments.

Q. 2. *Give the number of segments in the whole body.*

Ans. There are about 120 segments in the whole body.

Q. 3. *What are the locomotory organs in earthworm ?*

Ans. The locomotory organs are called as 'setae' which are elongated 'S' shaped structures made up of chitin.

Q. 4. *Where does it live ?*

Ans. It lives in burrow formed by it in the moist soil.

Q. 5. *How will you identify its burrow ?*

Ans. Small round balls are placed round the burrow on earth surface and in the presence of these balls the burrow is identified.

Q. 6. *What type of fertilization is found in earthworm ?*

Ans. Though earthworm is bisexual but only one type of sex is matured at a time. So cross fertilization takes place in them.

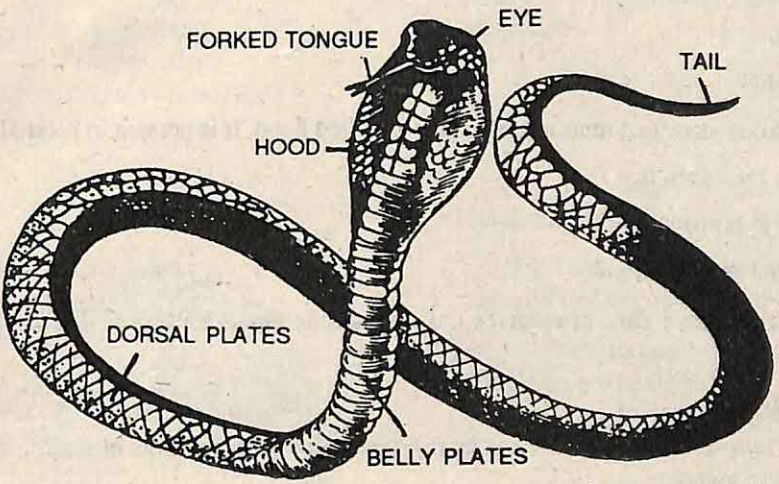


Fig. 3.6.12 A Cobra

9. SNAKE (Ophida)

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Super class	Tetrapoda
Class	Reptilia
Type	Snake

Characters :

(i) Snake is the member of class Reptilia.

(ii) Its body is cylindrical which is helpful in burrowing.

(iii) Body is covered by scales which are made up of nonliving cells. They protect the body.

(iv) It has no forelimb and hind limb which help in burrowing.

(v) It moves through creeping. Vertebral column helps in this activity.

(vi) Tail is present through out its life.

(vii) Its tongue is forked and has two fangs in the upper jaw which are connected with the poison glands. When it bites, the fangs insert in the body of prey, the poison glands are pressed and the poison is injected in the body of prey through fangs.

(viii) In some snakes like 'Naja' the lateral facial muscular walls are stretched in a special structure which is called as 'hood'. It helps in creating fear for the enemies.

(ix) Snake is unisexual. The female lays eggs in the burrows.

(x) The skin is dry, smooth and spotted which helps in burrowing and escaping from the grip of the enemies.

ORAL QUESTIONS

Q. 1. *How does the snake move ?*

Ans. By creeping.

Q. 2.*What is hood ?*

Ans. The facial broad stretched muscular structure is called hood. It is present in Naja-Naja.

Q. 3. *Where does the snake live ?*

Ans. Snake lives in burrows.

Q. 4. *How does the snake listen ?*

Ans. Snake does not have ears. It receives only vibrations through its skin. These vibrations act as hearing.

Q. 5. *What is fang ?*

Ans. Fangs are two hollow teeth present in the upper jaw in front side in snake. These fangs are connected with poison glands.

Q. 6. *Are all snakes poisonous ?*

Ans. No. Some species of snakes are poisonous while some other species are non-poisonous.

10. RAT (Ratus ratus)

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia
Type	Ratus ratus. (Rat)

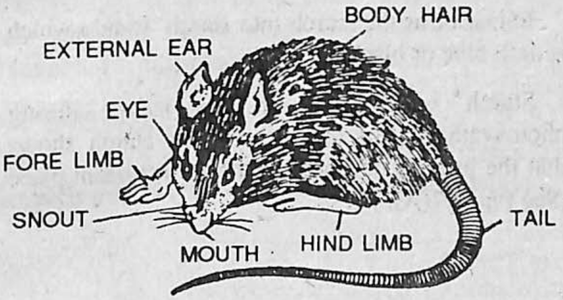


Fig. 3.6.13 Rat

Characters :

Rat is the member of class Mammalia. It is fully adapted to burrowing habitat with the following characters:

(i) Whole body is covered by hairs which help in protecting the life from the climatic adverse effect.

(ii) The mouth is having a long snout which helps in making burrow.

(iii) Teeth are present in both the jaws. Incisors are well developed which help in cutting the herbs.

(iv) The forelimbs and hind limbs are having five fingers (Pentadectyla) with sharp nails. These nails also help in cutting the food, gripping the food and making burrow.

(v) It is unisexual. The female gives birth to young ones.

(vi) Tail is present throughout the life.

ORAL QUESTIONS

Q. 1. *What is the Zoological name of rat ?*

Ans. Ratus ratus.

Q. 2. *Where does the rat live ?*

Ans. Rat lives in the burrows formed by itself in the fields and in the kachha houses.

Q. 3. *What type of nature of feeding the rat possesses ?*

Ans. The rat has well developed incisors in its both the jaws which helps in cutting the food into fine or tiny pieces.

Q. 4. *How does it increase its race ?*

Ans. Rat is unisexual animal. The female gives birth to young ones which increase the race.

Q. 5. *How does it harm to human beings ?*

Ans. Rat is harmful to man in the following ways :

(i) It eats the grains. (ii) It cuts the young stems of the plants (iii) It is the host of ticks which spread plague.

ORAL QUESTIONS

Q. 1. *How does the snake move ?*

Ans. By creeping.

Q. 2.*What is hood ?*

Ans. The facial broad stretched muscular structure is called hood. It is present in Naja-Naja.

Q. 3. *Where does the snake live ?*

Ans. Snake lives in burrows.

Q. 4. *How does the snake listen ?*

Ans. Snake does not have ears. It receives only vibrations through its skin. These vibrations act as hearing.

Q. 5. *What is fang ?*

Ans. Fangs are two hollow teeth present in the upper jaw in front side in snake. These fangs are connected with poison glands.

Q. 6. *Are all snakes poisonous ?*

Ans. No. Some species of snakes are poisonous while some other species are non-poisonous.

10. RAT (Ratus ratus)

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia
Type	Ratus ratus. (Rat)

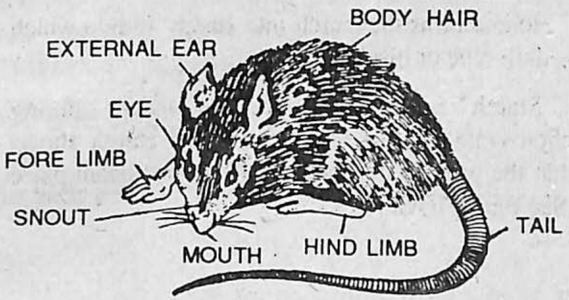


Fig. 3.6.13 Rat

Characters :

Rat is the member of class Mammalia. It is fully adapted to burrowing habitat with the following characters:

(i) Whole body is covered by hairs which help in protecting the life from the climatic adverse effect.

(ii) The mouth is having a long snout which helps in making burrow.

(iii) Teeth are present in both the jaws. Incisors are well developed which help in cutting the herbs.

(iv) The forelimbs and hind limbs are having five fingers (Pentadectyla) with sharp nails. These nails also help in cutting the food, gripping the food and making burrow.

(v) It is unisexual. The female gives birth to young ones.

(vi) Tail is present throughout the life.

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Q. 5. *How does it harm to human beings ?*

Ans. Rat is harmful to man in the following ways :

(i) It eats the grains. (ii) It cuts the young stems of the plants (iii) It is the host of ticks which spread plague.

EXPERIMENT 3.7

To test starch formation in the leaves and to show that chlorophyll is necessary for photosynthesis.

EXPERIMENT 3.7 (A)

To study the presence of starch in the provided leaf.

Starch Test

Take the potted plant, keep it in sunlight for sufficient time. Take any leaf on the plant for starch test. Boil it in the water for 5 or 6 minutes. Take out the leaf from the boiled water and put it in the hot amyl alcohol of 60°C till the leaf becomes colourless. Take out the leaf from alcohol. Wash it with cold water. Pour two or three drops of dilute Iodine solution on the colourless leaf. It turns dark blue or black which shows the presence of starch.

Iodine turns the starch into starch Iodide which is dark blue or black in colour.

Starch is prepared in the leaves during photosynthesis. So the presence of starch shows that the process of photosynthesis has taken place [See Fig. 3.7(A).]

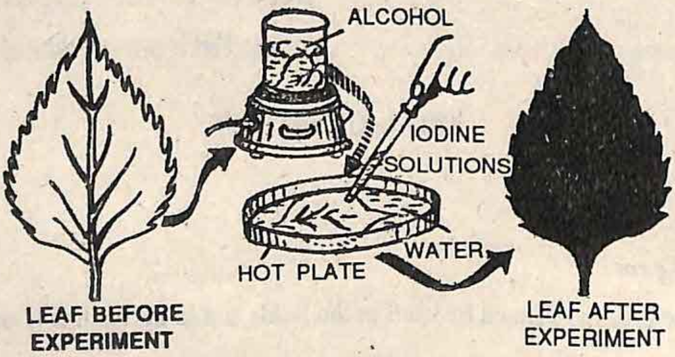


Fig. 3.7(A) Strarch Test

EXPERIMENT 3.7 (B)

To prove that chlorophyll is necessary for photosynthesis.

Required material : Croton leaf or pothos leaf, water, petri dish, lead pencil.

Procedure :

Take the potted plant of croton or pothos. (Croton or Pothos leaves are variegated. Mark the white spots or of any other colour except green colour with lead pencil. Place the potted plant in the sunlight for sufficient time. (See Fig. 3.7(B).]

Observation :

Pluck the leaf from the plant and test for starch. The green parts of the leaf turned dark blue while the white or of other colour spots do not turn blue which show the absence of starch.

Result :

It shows that chlorophyll is necessary for photosynthesis.

Precautions :

(i) Take croton or pothos leaf or leaves of any other plant which is variegated.

(ii) The spots of colour other than green should be marked with lead or water mark pencil.

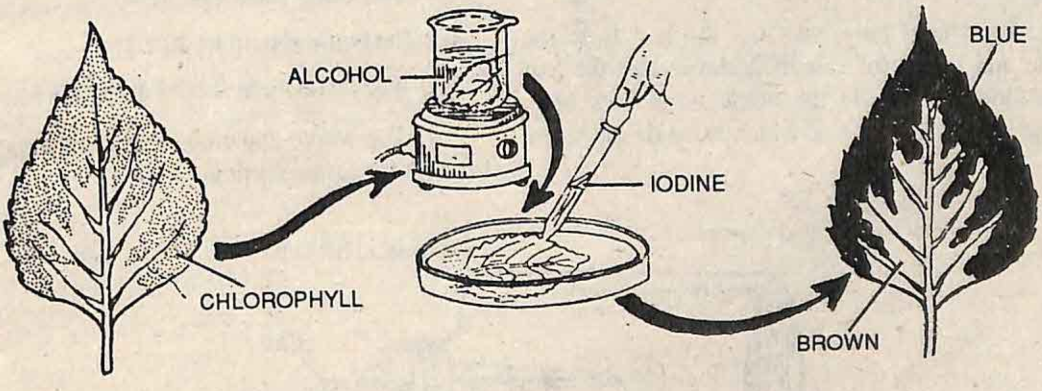


Fig. 3.7(B) Experiment showing chlorophyll is neccessary for photosynthesis

EXPERIMENT 3.8

To show that carbon dioxide is necessary for photosynthesis.

Required material : Wide mouthed bottle, freshly prepared lime water, bifurcated cork, petri dish, water, freshly plucked leaf.

Procedure :

Take a small quantity of freshly prepared lime water or KOH solution in the bottle. Keep it horizontally. Now take a freshly plucked leaf. Fix the leaf in between both the halves of the cork and insert it in the mouth of the bottle. The apex of the leaf should be inside the bottle. Dip the free end of the petiole in the water of petri dish. Place the whole apparatus in sunlight (See Fig. 3.8).

Observation :

After a fixed time, take out the leaf from the bottle and test it for starch. It shows that the leaf part which is outside the bottle turns dark blue. While the part of the leaf which is inside the bottle does not turn blue which shows the absence of starch.

Result :

The conversion of the leaf colour into dark blue shows the presence of starch which is formed during photosynthesis. The leaf part inside the bottle does not turn blue due to the absence of carbon dioxide. Thus this experiment shows that carbon dioxide is essential for photosynthesis.

Precautions :

(i) The leaf should be fresh.

(ii) Lime water should be fresh.

(iii)The bottle should be air-tight.

(iv) The leaf petiole should dip in the water.

(v) The whole apparatus should be kept in the sunlight for sufficient time.

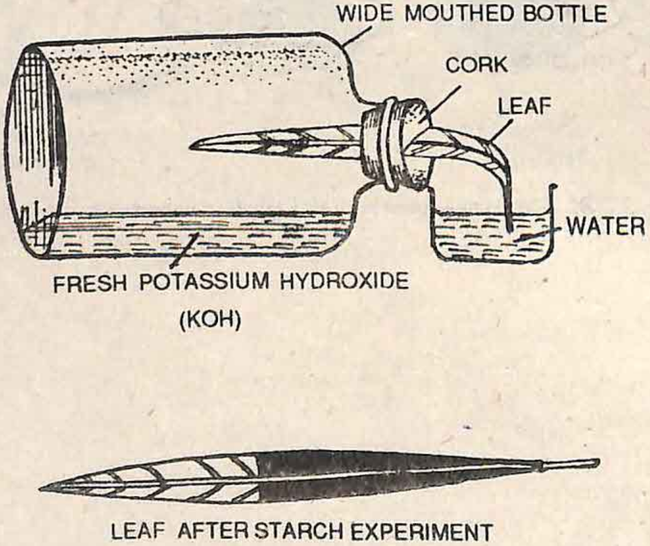


Fig. 3.8.
Moll's half leaf experiment

EXPERIMENT 3.9

EXPERIMENT 3.9 (A)

To show that sunlight is necessary for photosynthesis.

Required material : Ganong's Light Screen apparatus, potted fresh green plant,water.

Method :

Take the fresh green leaf. Fix it in Ganong's light screen apparatus. The distal free end of the petiole should dip in the water of petri dish. Keep the whole apparatus in sunlight. Mark that part of the leaf which was getting sunlight.

Observation :

After a definite time take out the leaf from the light screen apparatus and test for starch.

In starch test, that part of the leaf which was getting sunlight, turned dark blue while the other part of the leaf which was in the dark, did not turn blue.

Result :

The above result shows that sunlight is necessary for photosynthesis.

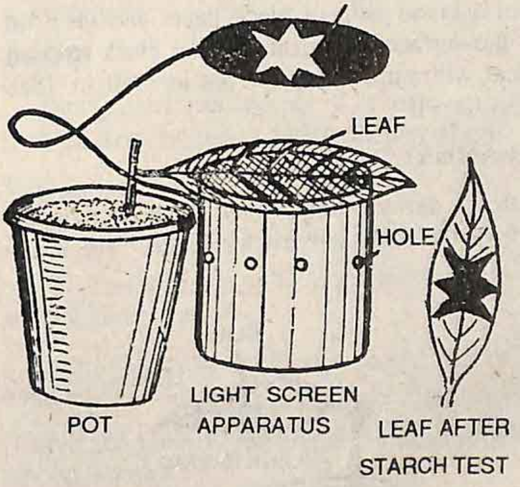


Fig. 3.9(A)
Ganong's Light Screen apparatus

EXPERIMENT 3.9 (B)

Second experiment to show that sunlight is necessary for photosynthesis.

Required material : (i) Potted plant (ii) Black paper (iii) Clips.

Method :

Cut a broad strip of black paper and tie it on both the surfaces of a leaf. Fix the black strip on the leaf with clips. Keep the pot in sunlight [See Fig. 3.9(B)].

Observation :

After a definite time, pluck the black stripped leaf from the plant and test for starch. The black stripped part of the leaf does not turn blue while the other part of the leaf turned blue.

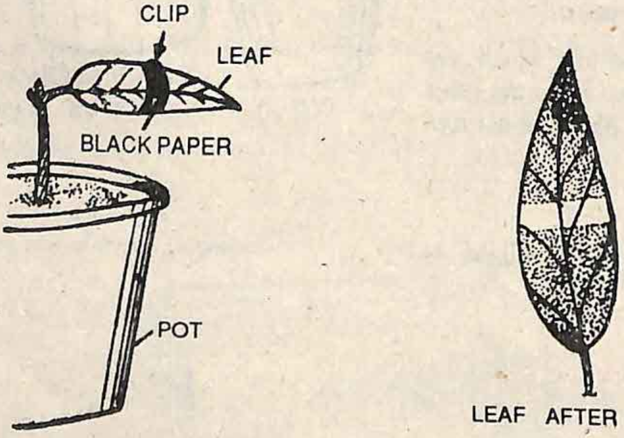
Result :

This experiment shows that sunlight is necessary for photosynthesis.

Precautions :

(i) The potted plant should be kept in sunlight for sufficient time.

(ii) The leaves should be covered with a black strip. This part of leaf should not get sunlight.



LEAF AFTER STRACH TEST

Fig. 3.9(B) Sunlight is neccessary for Photosynthesis

EXPERIMENT 3.10

To show that oxygen evolves during photosynthesis from plants.

Material Required : (i) Beaker (ii) Water (iii) Funnel (iv) Test tube (v) Hydrophytic plant (Hydrilla) (vi) Match box (vii) Sodium bicarbonate.

Procedure :

Take a twig of hydrophytic plant (Hydrilla). Put it in a beaker full of clean water. Add a pinch of sodium bicarbonate so that the quantity of carbon dioxide may not reduce. Cover the plant with the inverted funnel. Put the inverted test tube full of water over the funnel. Put the whole apparatus in sunlight.

Observation :

After some time, observe the gas bubbles coming out from the plant which collect at the top of the test tube by replacing water. Thus fill few test tubes with the gas.

Now bring the burnt match stick near the mouth of the test tube. What do you find ? The match stick burns more rapidly which proves that evolved gas is oxygen.

Result :

This experiment proves that oxygen gas is evolved from the plants during photosynthesis.

Precautions :

(i) Hydrophytic plant should be fresh.

(ii) Test tube should be filled with water before starting the experiment.

(iii) Complete apparatus should be kept in sunlight.

(iv) The joint of test tube and funnel should be dipped in water.

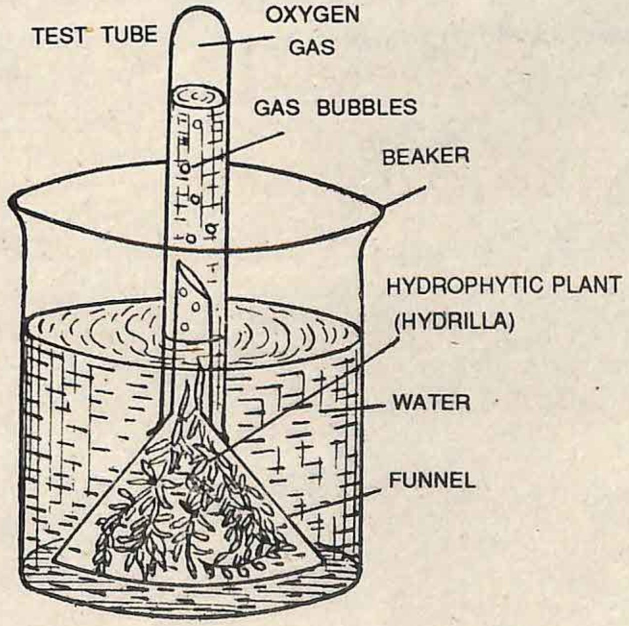


Fig. 3.10
Oxygen is liberated during photosynthesis

EXPERIMENT 3.11

To show that carbon dioxide is produced during respiration.

Required Material : Germinating gram seeds, conical flask, beaker, cork, thread, small and thin test tube (Ignition tube) delivery tube bending at two places in the same side, water, Potassium hydroxide solution.

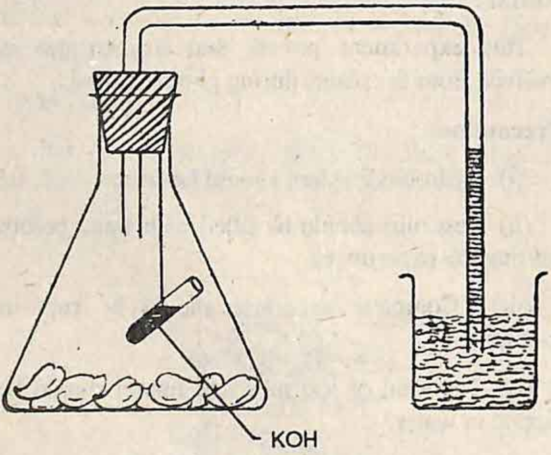


Fig. 3.11 Aerobic respiration

Procedure :

Take a conical flask. Put a few germinated gram seeds in it. Close the mouth with a cork having one hole in the centre. In this hole, a side of a delivery tube which is turned at two right angles in the same direction is fitted. The other end of the tube is put in a beaker which is containing freshly prepared lime water (KOH). Put the whole apparatus in an open place for some time.

Observation :

You will find that a gas is evolving from the germinating seeds which is mixing with the lime water and is converting it into milky solution.

Result :

Conversion of lime water into milky coloured solution proves that the evolved gas is carbon dioxide.

ORAL QUESTIONS

Q. 1. *What is photosynthesis ?*

Ans. Photosynthesis is a process under which the carbon dioxide reacts with water in the green parts of the plants in presence of sunlight to form complex organic compounds which are commonly called as food.

Q. 2. *What are the raw materials for the synthesis of food ?*

Ans. Carbon dioxide (CO_2) and water (H_2O)

Q. 3. *What are the two factors essential for photosynthesis ?*

Ans. Chlorophyll and sunlight.

Q. 4. *In which form sunlight is utilized in photosynthesis ?*

Ans. Solar energy is utilized in the form of chemical energy.

Q. 5. *What is the role of chlorophyll in photosynthesis ?*

Ans. Chlorophyll is complicated green pigmented powder. Its one component *i.e.* chlorophyll 'a' receives the radiant energy from sunlight and converts it into chemical energy.

Q. 6. *If the day is cloudy. Explain whether the photosynthesis will occur or not.*

Ans. In cloudy day the photosynthesis will not take place due to the absence of sunlight.

Q. 7. *Why is KOH used in one of the experiments of photosynthesis ?*

Ans. Freshly prepared KOH solution has the property to absorb CO_2. So it is used in showing the necessity of CO_2 in photosynthesis.

EXPERIMENT 3.12

To show that heat is produced during respiration.

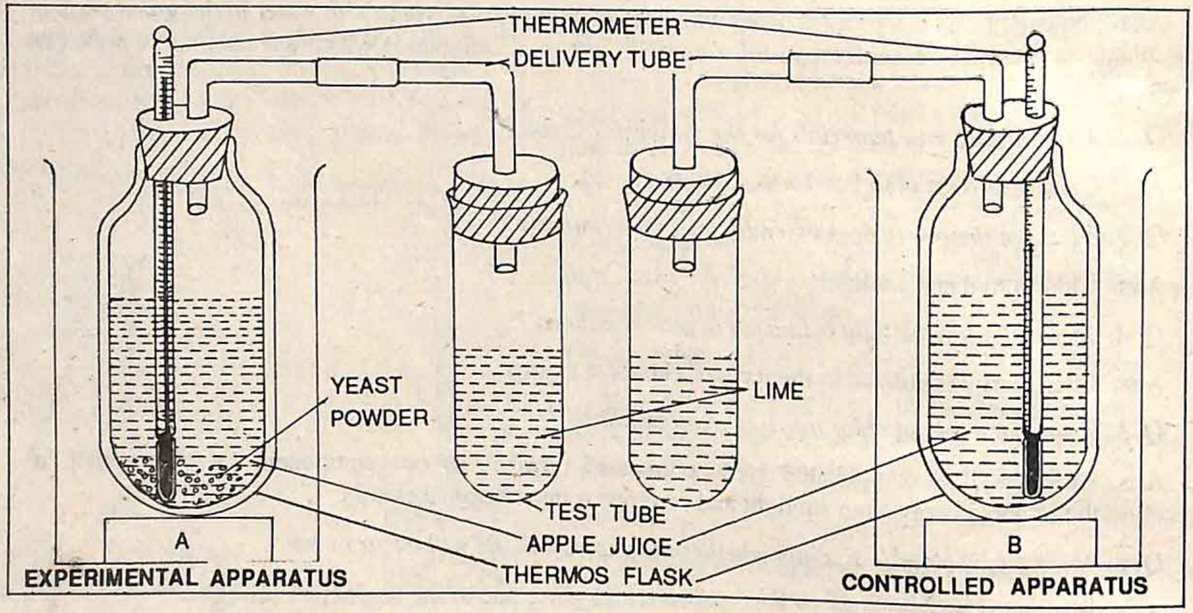


Fig. 3.12 Experiment to show that heat is evolved during respiration

Material required : Two thermos flasks, two thermometers, yeast powder, fresh apple juice, rubber tubes, two stoppers with one hole, Two rubber stoppers with two holes in each two test tubes, delivery tubes, lime water.

Method :

Take two thermos flasks. Put the equal quantity of apple juice in both the flasks. In thermos flask 'A' put about 2 grams yeast powder. Let the flask 'B' remain with only apple juice. Close the flasks with corks having two holes in each. Now fill the freshly prepared lime water in two test tubes. Close their mouths with the help of corks having one hole. Insert delivery tube in each cork. In each flask insert one thermometer and a delivery tube. Make the contact of each delivery tube of test tube with the delivery tube of thermos flask with the help of rubber-tubes. Flask 'B' acts as the controlled apparatus. Keep both the apparatuses at open place in sunlight for a long time.

Observations :

Observe the changes taken place in both the flasks and write them in the table below:

S. No.	Interval-time	Thermos flask 'B' (Controlled)			Thermos flask 'A' (Experimented)		
		Readings of thermo-meter	Level of juice in the delivery tube	Change in the lime water	Readings of thermo-meter	Level of juice in the delivery tube	Change in the lime water
1.	12 hours						
2.	24 hours						
3.	36 hours						
4.	48 hours						
5.	60 hour						

On observing the readings of both the thermometers it is clear that the level of mercury in the thermometer of flask 'A' has increased.

Result :

This experiment shows that temperature is increased during respiration of yeast cells.

Precautions :

1. Lime water should be freshly prepared.
2. Amount of apple juice or orange juice should be taken in equal quantity in both the thermos flasks.
3. Both the flasks should be air-tight.
4. The whole apparatus should be placed at one place.

EXPERIMENT 3.13

To measure the body temperature and pulse rate.

Required material : One clinical thermometer, one stopwatch.

Measurement of Body temperature :

The body temperature is measured with the help of clinical thermometer. It is graduated in Fahrenheit. It starts from 90°F till 108°F. The body temperature of normal human is 98·4°F. Therefore, a red arrow is placed vertically at that reading.

The body temperature is taken from the buccal cavity or from armpit. The temperature of buccal cavity is one degree more than the temperature of armpit.

Method :

(i) Handle the thermometer carefully. Wash it with clean and cold water wholly or its mercury containing bulb so that the disease germs of one person may not transfer to the other. Moreover the mercury level may fall off and the whole amount of mercury may be stored in the bulb region.

(ii) Now put the thermometer in the armpit in such a way that its mercury containing bulb may completely be in touch with the arm and lateral side of thorax.

(iii) Keep the thermometer in the same position for atleast one minute time.

(iv) Then take out the thermometer gently and note the reading of mercury level by keeping it horizontally before the eyes.

If the thermometer is put in the buccal cavity in place of armpit. Put the mercury bulb of thermometer just below the tongue in between tongue and lower palate. Close the mouth gently. Note that the teeth should not touch the thermometer. Keep the thermometer in the same position for atleast one minute time.

Then take out the thermometer gently and place it horizontally before the eyes and note down the level of mercury.

You will find that the temperature of the buccal cavity is one degree more than that of armpit.

Below 93°F and above 105°F the temperature shows the signs of serious condition. So man should take precaution to save the life.

Precautions :

1. Thermometer should be thoroughly washed with cold and clean water before and after use.
2. Thermometer should be safely and properly handled.
3. The mercury bulb of thermometer should be thoroughly in touch with the body while use and should not be disturbed.
4. The mercury bulb should not come in direct contact with the atmospheric air while in use.

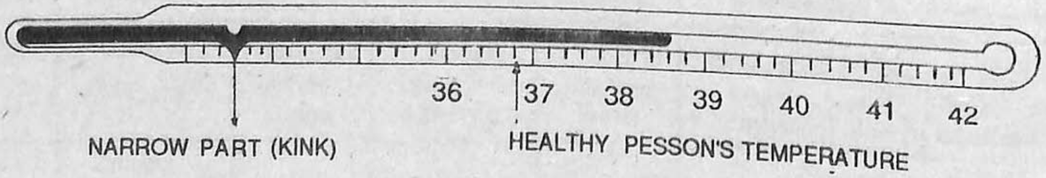


Fig. 3.13. Clinical Thermometer

Measurement of Pulse Rate :

The pulse rate of human body can be measured by the help of other person and a stop watch. Generally the pulse rate is measured at rest and after work or exertion. So for measuring the pulse rate, let the person (object) be at rest for atleast ten minutes and then hold the wrist in such a way that the first, second and third finger of the observer may press gently to the blood vessel running parallel the thumb of the object and the thumb of the observer should be opposite to his fingers. Now count the beatings of the blood vessel in one minute. Repeat the same exercise two or three times and find out the mean.

Second time, ask the object (person) to run for atleast one minute and then count the pulse rate two or three times and find out the mean. Note down the observations in the table given below :

Result :

The pulse rate of a male/female person of age.............................years is—

at rest.....................per minute.

After exercise.........per minute.

S. No.	Conditions of the object (Person)	Age	Sex	No. of Pulse in one minute			mean
				I time	II time	III time	
1.	Object at rest position.						
2.	Object after running or exercise.						

ORAL QUESTIONS

Q. 1. *Why do we take germinating seeds in the experiment ?*

Ans. During germination, energy is needed which is obtained from the food stored in the seeds. The food is converted into simple forms and energy during catabolism.

Q. 2. *Do germinating seeds breathe or respire ?*

Ans. Germinating seeds respire.

Q. 3. *In the provided experiment what does the rising water show ?*

Ans. The rising of the water level in the delivery tube shows the decreasing of air volume in the apparatus due to the consumption of oxygen during respiration.

Q. 4. *What are the products during respiration ?*

Ans. Carbon dioxide and heat is evolved during respiration.

Q. 5. *Can wood be taken in place of dry seeds in the experiment ?*

Ans. Yes, wood can be taken in the experiment in place of dry seeds because both do not respire.

Q. 6. *What is the advantage of cotton wool in the experiment ?*

Ans. Cotton wool is non-conductor of heat so it does not allow heat to expel out from the thermos flask.

Q. 7. *Why do we measure the pulse rate at rest and after exercise ?*

Ans. Though respiration takes place for all time but at rest energy is needed in less quantity so pulse rate is slow while during exercise more energy is needed so pulse rate becomes fast. It shows that energy is more needed during exercise.

Q. 8. *Which type of thermometer is used for measuring the human body temperature ?*

Ans. Clincial Thermometer.

Q. 9. *Which part of the body is most suitable for measuring the pulse ?*

Ans. Wrist.

Q. 10. *What part of thermometer should be in contact with the body ?*

Ans. Bulb of thermometer which contains mercury.

EXPERIMENT 3.14

To identify organisms on the basis of their food habits as autotrophs, heterotrophs, parasites, saprophytes, saprozoic, symbiosis.

EXPERIMENT 3.14 (A)

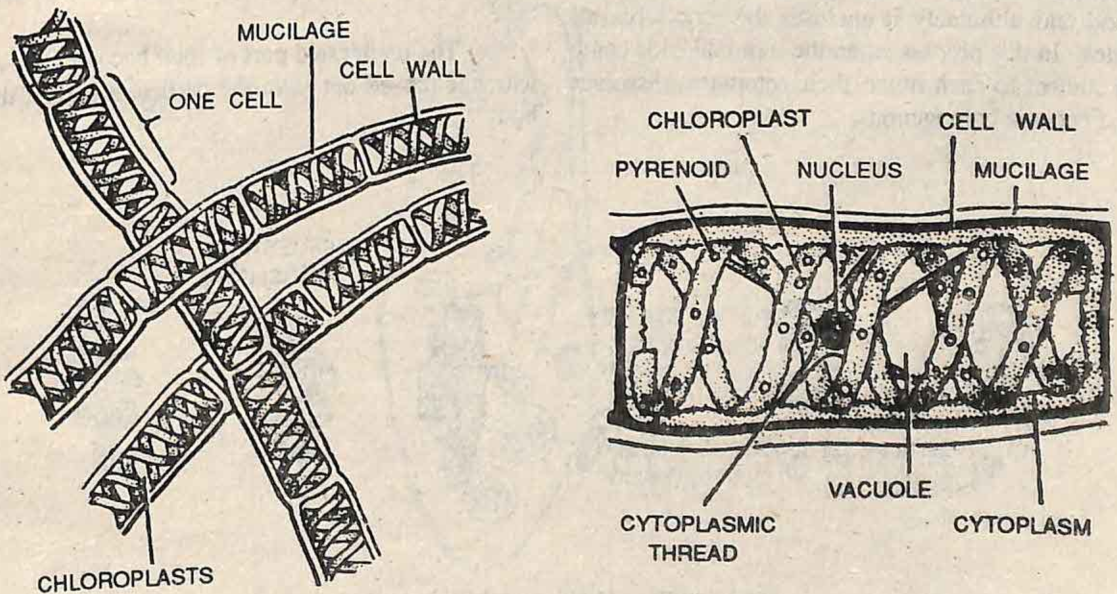
Observation of Algae (Spirogyra) in special reference with the autotrophic food habit.

Required Material : Pond/Sewer water with scum, Plain slide, Needle, Compound microscope, Cover slip, Water.

Observation :

Spirogyra is called a pond scum as it is generally found in ponds, ditches, tanks etc. It is thread like, unbranched, green and multicellular. Numerous threads lie at the bottom of the pond irregularly to form a dense network. Therefore this network is also called as the pond-carpet.

Each cell of each thread is green due to the presence of chloroplasts. Each cell is able to prepare its own food in presence of sunlight. Therefore, spirogyra is called as the autotroph. It is independent for its food.



Spirogyra — Unbranched filaments

Spirogyra cell

Fig. 3.14(A)

EXPERIMENT 3.14 (B)

To examine amoeba on the basis of its food habit.

Required Material : Chart or model of Amoeba showing food capturing mechanism.

Observation :

Mode of capturing of food by Amoeba through Pseudopodia.

(i) Amoeba is holozoic animal. It engulfs the whole body of Bacteria, Diatoms, other Protozoa and Algae in the form of its food.

(ii) It does not have any definite mouth. It captures the food material through its pseudopodia by surrounding the food.

(iii) In the beginning, it forms a cup like structure through pseudopodia surrounding the food and ultimately it encloses the food from all sides. In this process when the terminal ends come in contect to each other, their ectoplasm dissolves and become homogenous.

(iv) Now the prey goes in the plasma in the form of a food vacuole.

(v) Many digestive enzymes are formed in the cytoplasm which on coming in contact with the food vacuole, convert the ectoplasm into soluble form.

(vi) The digestive enzymes come in contact with the prey (food) directly.

(vii) This food vacuole moves in all the parts of the body of Amoeba along with the cytoplasm during cyclosis.

(viii) The dissolved food material diffuse out from the food vacuole in different parts of the body.

(ix) The undigested part of food becomes heavy which is passed out from the particular part of the body.

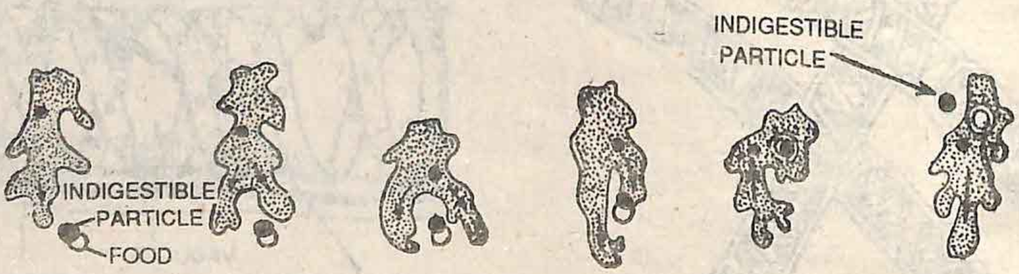


Fig. 3.14(B) Mode of nutrition in Amoeba

EXPERIMENT 3.14 (C)

Examination of Paramaecium on the basis of its food habit.

Required Material : Model or chart of Paramaecium showing feeding mechanism.

Observation :

(i) Paramaecium is a unicellular slipper shaped animal. There are numerous tiny, thin cilia on the outer suface of the body.

(ii) There is an oral groove at one side of the body.

(iii) Special row of cilia push the tood particles along with the current of water towards the oral groove.

(iv) When the food enters in the oral groove. Gullet opens towards innerside through cytosome.

(v) Now the food enters in the cytoplasm in the form of food vacuole where it moves in the cytoplasm through cyclosis. Good food elements are distributed in all the parts of cytoplasm from the food vacuole.

(vi) The remaining part of food is undigested which is passed out from the body through cytopyge.

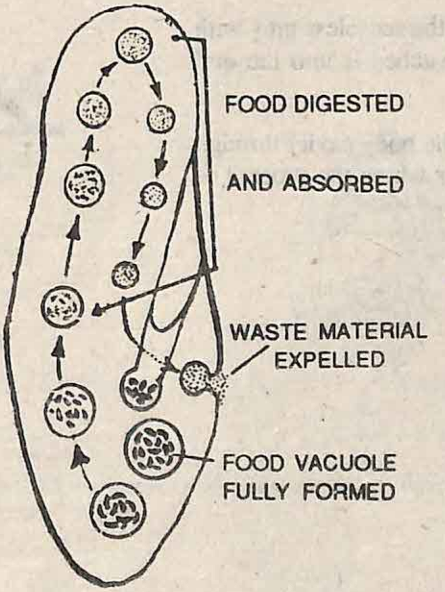


Fig. 3.14(C) Nutrition in Paramaecium

EXPERIMENT 3.14 (D)

Examination of Hydra on the basis of its food habit.

Required Material : Model or chart of feeding mechanism of Hydra.

Observation :

(i) There are 6-10 thread like structures around the mouth called 'tentacles'.

(ii) There are special type of cells called Nematocysts or Nematoblasts or cnidoblasts or stinging cells.

(iii) When the floating food material comes in contact with the tentacles, the stinging cells enter in the body of prey. A poisonous juice is secreted out from the stinging cells which enter in the body of prey due to which the prey becomes senseless.

(iv) Now Hydra captures the senseless prey with the help of tentacles and snatched it into the oral groove.

(v) This prey reaches in the body cavity through oral groove along with water where the process of digestion starts on it.

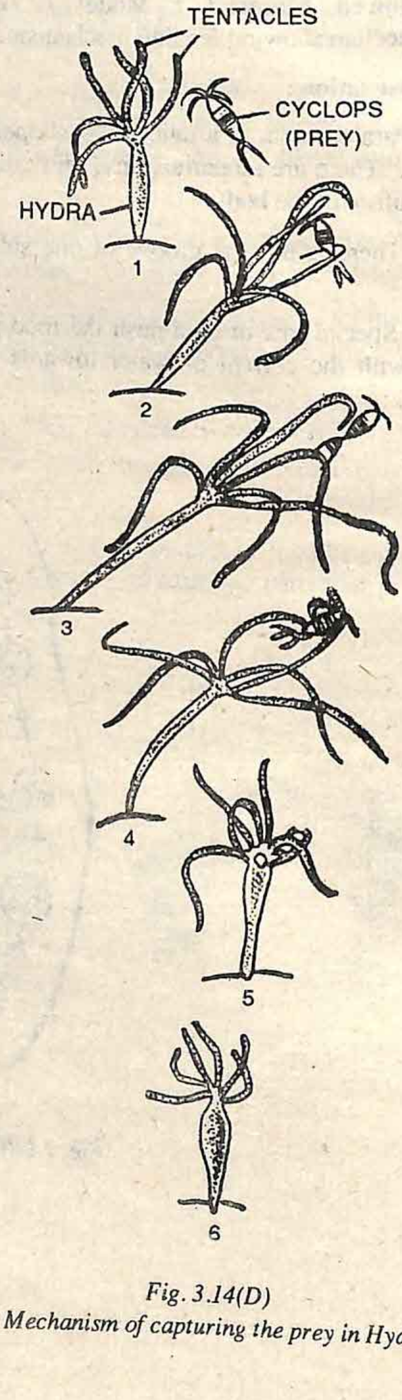


Fig. 3.14(D)
Mechanism of capturing the prey in Hydra.

EXPERIMENT 3.14 (E)

To identify the organism on the basis of its Parasitic food habit.

Required Material : A twig of host plant with a Cuscuta, plain slide, cover slip, blade, microscope.

Procedure :

Take a portion of the host plant containing Cuscuta plant. Cuscuta or Cuspita is yellow, cylindrical, branched thread like structure which covers the body of the host plant. It is connected with the host plant at various places. If you cut a transverse section of Cuscuta plant at the junction, you will find that there are several thread like roots (Haustoria) penetrating in the body of host and making contact with the vascular bundles of the host plant.

Result :

Cuscuta plant depends on the host plant for its food and shelter. This mechanism is called Parasitism.

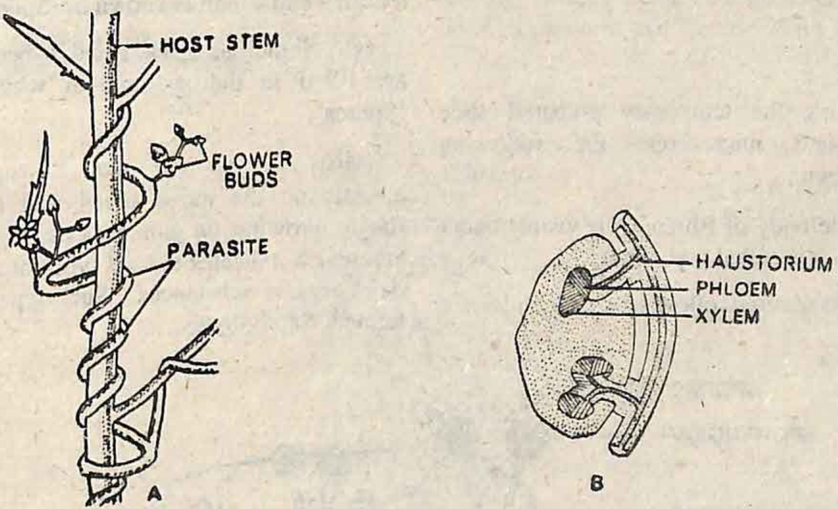


Fig. 3.14(E) Dodder or Cuscuta with haustoria or parasitic roots

EXPERIMENT 3.14 (F)

To identify the organism on the basis of its saprophytic food habit.

Required Material : Bread, water, watch glass, cotton blue stain, glycerine, plain slide, cover slip, forceps, petri dish.

Procedure :

Keep the moist bread at open place for two or three days. You will find some white network on the bread.

Root out some part of this network with the help of forceps. Place it on the plain slide and stain it with cotton blue stain. After half a minute put a drop of glycerine on it and mount it with a cover slip.

Observation :

On examining the temporary prepared slide under compound microscope the following structures are seen :

(i) The whole body of Rhizopus is visible under low power which is called mycelium.

(ii) There are several hollow tubes which form a transverse network. Each tube is called 'Hypha' and its plural is 'Hyphae'.

(iii) Each hypha is coenocytic i.e. many nuclei are present without any septum.

(iv) Several downwards vertical growing structures are arising from each node which are called 'Rhizoidal Hyphae'.

(v) Few vertically upward tubes are also arising which are known as 'Sporangiophores'.

(vi) A bulb like structure is present at its terminal end which is known as 'Sporangium'.

(vii) Numerous black, small, spherical structures are filled in the sporangium which are called 'Spores'.

(viii) As you see that Rhizopus (Fungus) appears on the moist bread you can also find fungus growing on jam, pickles, log, moist shoes etc. which indicates that all types of fungi grow on dead organic substances. Such type of plants are termed 'Saprophytes'.

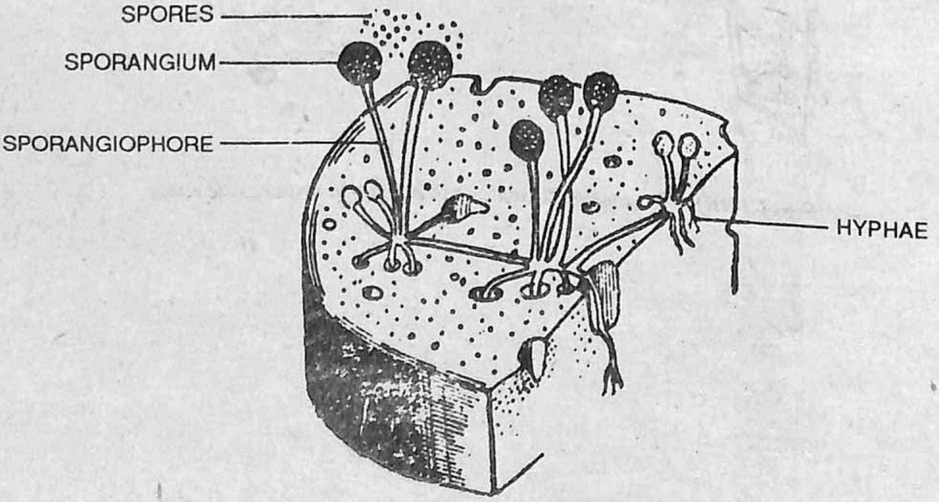


Fig. 3.14(F) Microscopic view of Fungi

EXPERIMENT 3.14 (G)

To identify organisms on the basis of their symbiotic food habit.

Required Material : Lichen or Pea or Gram plant with roots, Plain slides, cover slip, water, dissecting needle, microscope.

Procedure :

Take Pea or Gram plant with roots. Examine the roots carefully. You will find nodules at various places on the roots.

Take a nodule on a plain slide and tease it with the help of needle. Examine it under microscope.

Take a small piece of Lichen. Keep it in water for some time. Now take out the material from water. Put it on the plain slide and separate the lower white part from the upper green part with the help of needles. Spread it on the slide and examine it under the microscope.

Observation :

(i) Tiny bacteria are visible on the slide which are taken out from the nodule. They are nitrifying bacteria.

(ii) The lower part of Lichen is white in colour and is made up of fungus while the upper green part is made up of algae.

In slide 'A' nitrifying bacteria are benefitted by the leguminous plant and vice versa which is a good example of symbiosis. Slide 'B' also shows symbiosis.

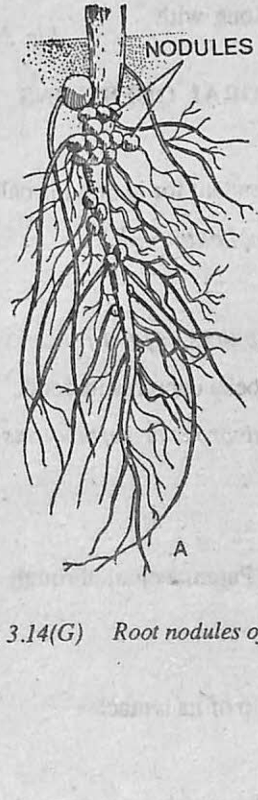


Fig. 3.14(G) Root nodules of Pea

EXPERIMENT 3.14 (H)

To examine the organism on the basis of saprozoic food habit.

Observations :

(i) Saprozoic organism are those which depend on the dead bodies of the animals for their food *e.g.* Kite, Eagle, Vulture, Owl, Falcon, Hawk etc.

(ii) They all are flight birds.

(iii) The beak is very powerful and hooked with the help of which they can tear the flesh of dead animals.

(iv) The whole body is covered by dark brown feathers.

(v) Tail is short but persists throughout the life.

(vi) The feet are strong and help in grasping the swiftly moving prey.

(vii) All the four toes are developed along with hallux.

(viii) Claws bear big size of Phalanges.

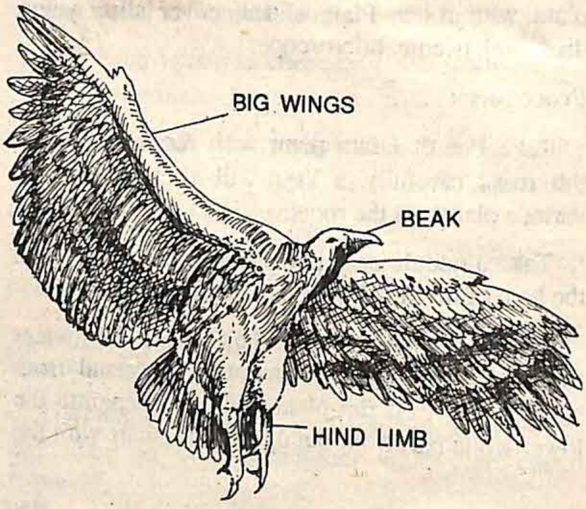


Fig. 3.14(H) Vulture—External Features

ORAL QUESTIONS

Q. 1. *What do you mean by autotroph ?*

Ans. The living organism who is independent for its food is called as Autotroph.

Q. 2. *Can you give one example of animal autotroph ?*

Ans. Euglena.

Q. 3. *With the help of which amoeba captures its food ?*

Ans. With the help of Pseudopodia, amoeba captures its food.

Q. 4. *State Amoeba is carnivorous, omnivorous or herbivorous ?*

Ans. Amoeba is carnivorous.

Q. 5. *What is cytopyge ?*

Ans. Cytopyge is an aperture in the Paramaecium through which the undigested food material is expelled out.

Q. 6. *How does Hydra inhale its prey ?*

Ans. Hydra catches its prey with the help of its tentacles.

Q. 7. *What is haustoria ?*

Ans. Haustoria are thread like structures which arise from the cuscuta and make its contact with the vascular system of the host plant.

Q. 8. *What do you mean by saprophyte ?*

Ans. Saprophytes are those plants which depend on dead organic substances for food.

Q. 9. *What is mycelium ?*

Ans. Mycelium is the network of hyphae.

Q. 10. *What do you mean by symbiosis ?*

Ans. Symbiosis is the property of living two organisms in such a way that both are benefitted from each other.

Q. 11. *What type of Bacteria do you find in the leguminous plants ?*

Ans. Rhizobium bacteria which are nitrifying bacteria.

Q. 12. *Where do the bacteria reside in the leguminous plant ?*

Ans. Bacteria live in the nodules, which are knot like structures.

Q. 13. *What is Saprozoic ?*

Ans. Saprozoics are those animals which survive on dead organic substances.

EXPERIMENT 3.15

Study of some local birds with reference to their food habits in relation to the modifications of their beaks and feet.

Though birds are the only vertebrates which occupy all the continents, oceans and islands but here we are concerned with only those birds which are generally seen all around us specially in India. All these birds vary from each other due to the variation of their mode of feeding and capturing the food, on the basis of which their beaks and feet vary in shape and size.

Beaks are suited to their food. Some of the birds with variation of beaks are as follows :

House Sparrow (Passer domesticus) :

These are commonly found in almost all the parts of India. They have the following main characters :

(i) It is unisexual. The male is identified from the female by having dark reddish-brown colour of back feathers and a black bear (a black spot from chin to breast), while the females have pale yellow black colour and have no black bear.

(ii) It freely moves in the house and makes its nest there.

(iii) Its beak is short, conical and peg like.

(iv) Two small apertures are the nostrils which are present at the base or broader end of the beak.

(v) The beak is the modified form of mouth forming snout.

(vi) Its beak is used for picking up small seeds which are swallowed or crushed.

(vii) It uses its beak in crushing the large and hard shelled seeds and fruit stones.

(viii) It has three long, slender like toes in the front while one toe, commonly known as hallux, is posteriorly placed. Such arrangement of toes help in holding the food and in perching on the tree automatically.

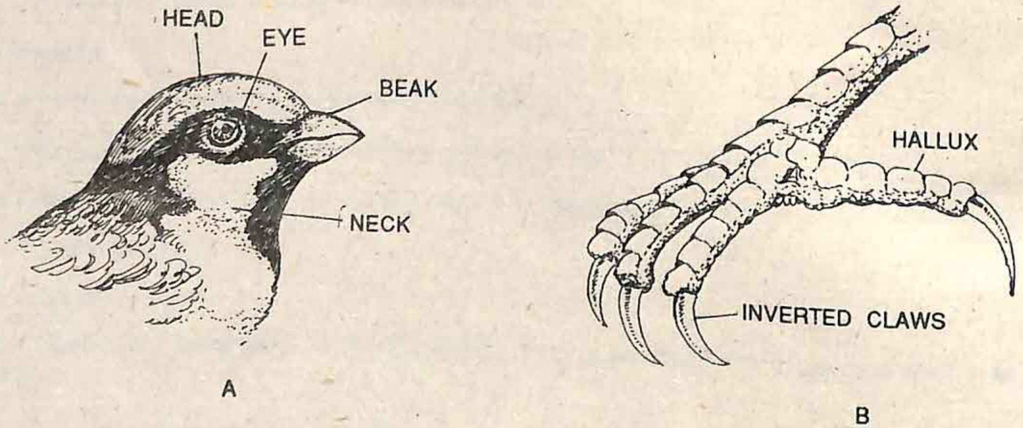


Fig. 3.15.1 Sparrow—A. External Features, B. Claws

ORAL QUESTIONS

Q. 1. *What is beak ?*

Ans. Beak is the modified form of mouth.

Q. 2. *How many toes are there in the feet of sparrow ?*

Ans. There are three toes in each foot of sparrow.

Q. 3. *What is hallux ?*

Ans. Hallux is a toe situated posteriorly in each foot.

Q. 4. *How will you identify the male from the female sparrow ?*

Ans. There is a black spot from chin to breast in the male sparrow which is absent in the female.

PIGEON (Columba livia)

(i) It is also very common in India.

(ii) Its whole body is covered with feathers which are grey, white, brown, red or verigated in colour on the back.

(iii) Its beak is also stout, conical and grainivorous.

(iv) The upper and lower beaks are covered by a horny sheath.

(v) There is a patch of skin at the base of upper beak which is called as CERE.

(vi) The feet have 3 toes in the front and fourth toe in the back having usually tarsus shorter than toes.

(vii) On removing the feathers from the whole body the pigeon looks very small with a long neck and short and pointed tail.

(viii) External ears are absent. Only a small aperture is present known as ear-opening.

(ix) Eyes are large, rounded with a circular pupil, nictitating membrane and movable eye lids.

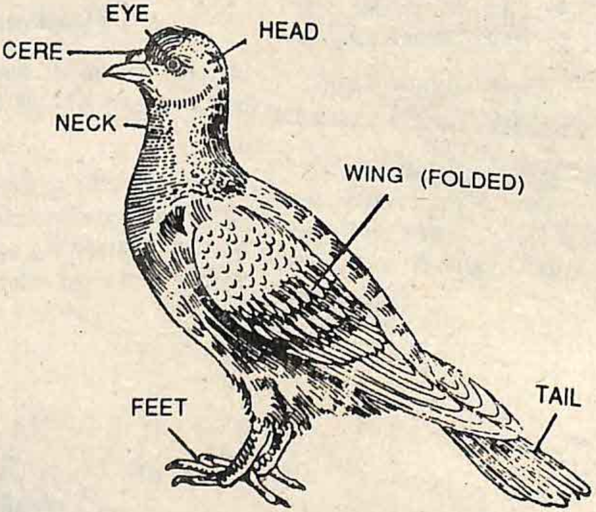


Fig. 3.15.2 Pigeon—External Features

PARROT (Psittacula eupatria)

(i) It is commonly found in fruit trees, ripe crops and in the forests.

(ii) Its voice is peculiar and sweet.

(iii) The whole body is green in colour with light green neck.

(iv) The male is identified from the female by having a red line in the neck.

(v) Its beak is small in size, stout, sharp-edged and hooked at the tip.

(vi) Its beak is red in colour.

(vii) The lower jaw is smaller than the upper one and is covered by the upper jaw.

(viii) Tail feathers are long.

(ix) The feet are adapted for climbing the vertical surface.

(x) The first and fourth toes are slightly backward with curved claws while second and third toes are facing forward.

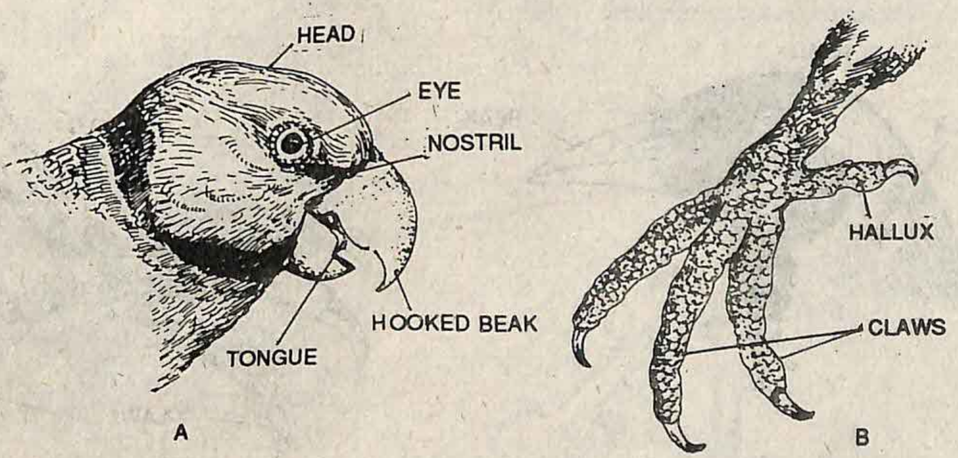


Fig. 3.15.3 Parrot—A. External Features, B. Claws

CROW (Corvus splendens)

(i) It is most common, familiar and intelligent bird which is easily recognised even by babies.

(ii) It is black in colour with grey neck.

(iii) It feeds on every eatable thing like bread, butter, fruits etc. and also the meat of dead animals and sputtum too.

(iv) Its beak is elongated and hard having two nasal apertures at the broader base.

(v) Beak has two cutting edges with the help of which it can cut the thing easily.

(vi) There are three long slender toes in each foot and a fourth toes is long and curved placed behind claw.

(vii) Each toe has long and curved claw.

(viii) Feet are adapted for perching.

(ix) Eyes are large and keen sighted.

(x) Tail feathers are elongated.

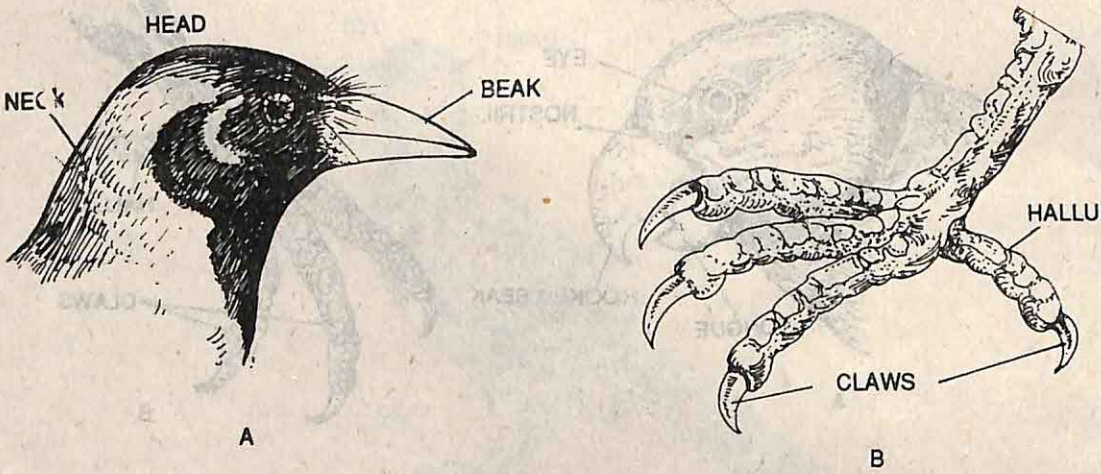


Fig. 3.15.4 Crow - A. External Features, B. Claws

COCK AND HEN (Fowl)

(i) Cock and hen are very common birds found in every part of India.

(ii) It is unisexual. The male is called cock while the female is called hen.

(iii) The whole body is covered with feathers which are generally white but may be brown, bluish-brown and orange in colour.

(iv) The cock is identified from hen by having large and well developed comb which is muscular, red and is dissected evenly at the edge.

(v) The beak is short, conical, stout and peg-like.

(vi) Vatel is bilobed, large muscular and bilobed which is well developed in cock and less developed in hen.

(vii) The hind limbs are covered with scales and have four toes in each limb.

(viii) Three toes are in front side which have long and curved claws while the fourth one is posteriorly situated which is comparatively shorter and is known as hallux.

(ix) The tail of cock is longer than hen.

(x) Vocal sacs are well developed in cock with the help of which it produces remarkable sound.

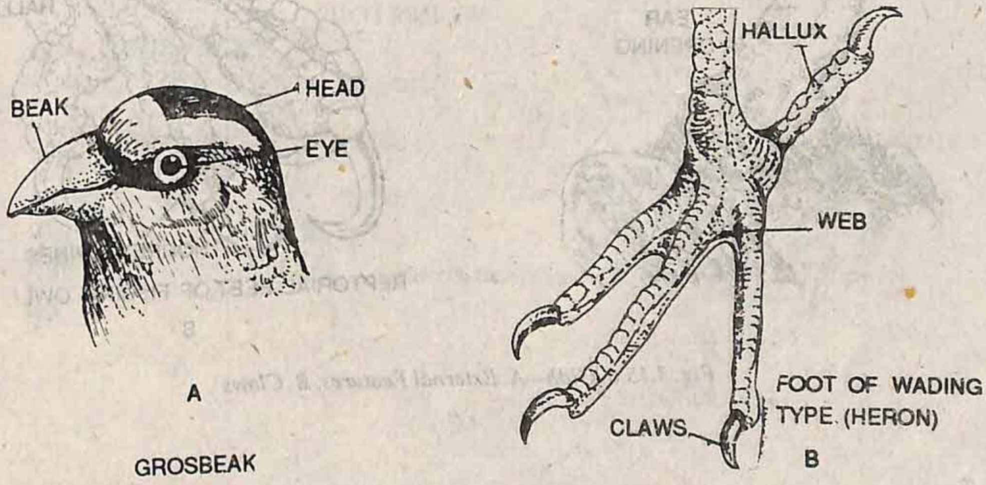


Fig. 3.15.5. Grain eating bird —A. External Features, B. Claws

GIDH (Gypus bengalensis)

(i) It is sufficiently a large bird with blackish brown in colour.

(ii) Head is without feather and possesses a pair of large eyes.

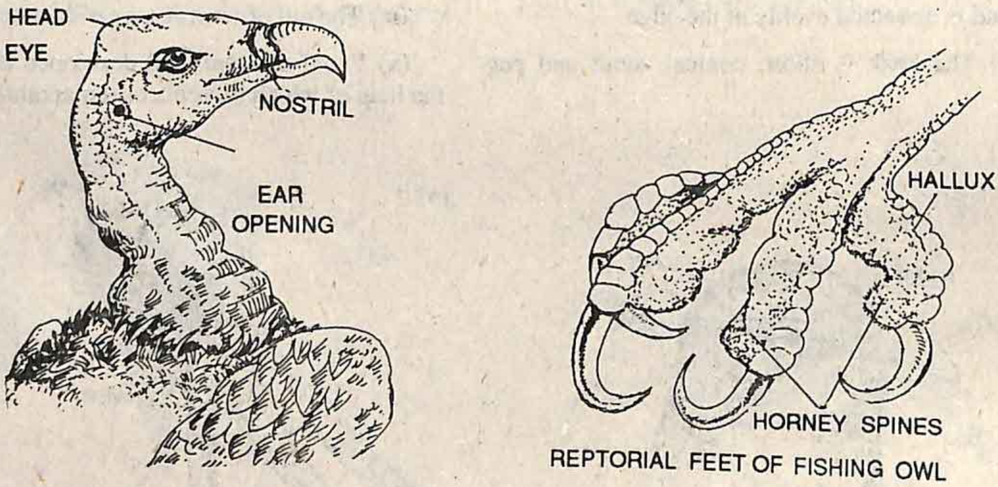
(iii) The wings are very large, well developed and are covered with strong big feathers.

(iv) The beak is stout. Its upper beak is curved at the tip like hook.

(v) Feet are also stout and are adapted for grasping with sharp claws. Three toes at front and one toe at the back.

(vi) They eat flesh of dead animals.

(vii) They produce special sound while they are in colonies or during flight.



REPTORIAL FEET OF FISHING OWL

B

Fig. 3.15.6 Gidh—A. External Features, B. Claws

OWL (Ketupa)

(i) It is a bird which is dark brown in colour.

(ii) Its feathers are less white spotted.

(iii) The feathers are delicate and can easily be detached from the skin.

(iv) Its face is white with well developed snout muscles.

(v) Beak is short, pointed, stout and sharp edged.

(vi) Beak is meant for tearing the flesh from the body of hunt.

(vii) There are four toes. Three out of four are in front and the fourth one is opposite to them facing anteriorly.

(viii) All the toes have sharp, horny and stout claws which are curved towards inner side which help in catching the slippery creatures.

(ix) The eyes are well developed placed ventrally on the face which are capable to see in the dark.

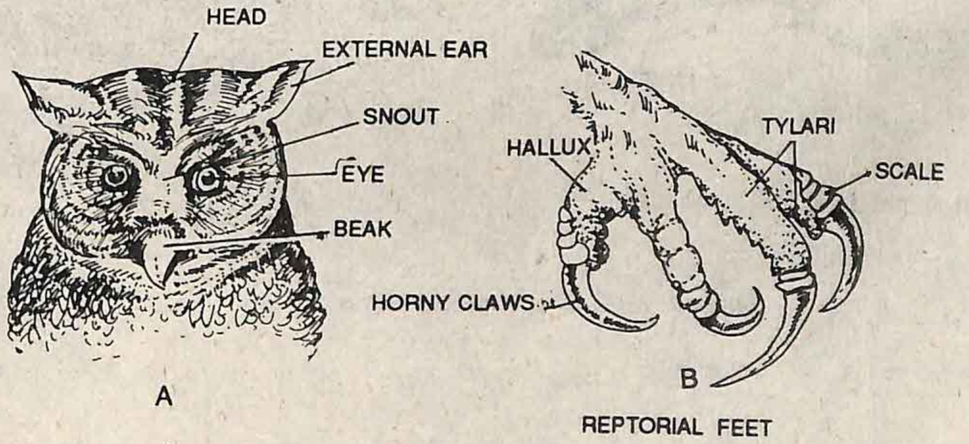


Fig. 3.15.7 Owl—A. External Features, B. Claws

CRANE (Phoenicopterus) (FLAMINGO)

(i) It is a pale white bird.

(ii) Body is divided into head, neck and body.

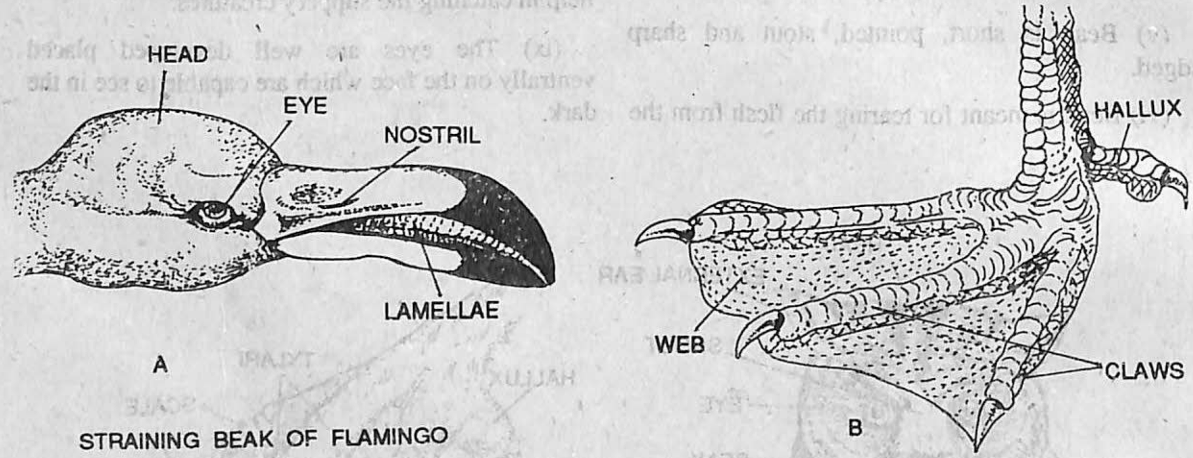
(iii) Neck is long, cylindrical and curved.

(iv) The beak is decurved in the middle.

(v) The legs are long and pink in colour.

(vi) Toes are interconnected with web.

(vii) The tongue is fleshy and acts as plunger.



STRAINING BEAK OF FLAMINGO

Fig. 3.15.8 Crane—A. External Features, B. Claws

PEACOCK (Pavo cristatus)

(i) This bird is very beautiful found in the forests and fields.

(ii) Its whole body is covered with small grey and green feathers.

(iii) The male peacock has long abnormally elongated feathers which are ornamented with several colours arranged in round spots with dark blue in centre.

(iv) Neck is long and cylindrical and metallic green in colour.

(v) The head has a crest like Cock.

(vi) The beak is short. Its anterior free end is narrow and slightly curved.

(vii) Feet are adapted for running and scratching the earth.

(viii) The legs are slightly long and stout.

(ix) It generally eats fruits and seeds and also newly sown seeds. It also hunts snakes and it eats small insects.

(x) The male dances to express its happiness while the female does not do so.

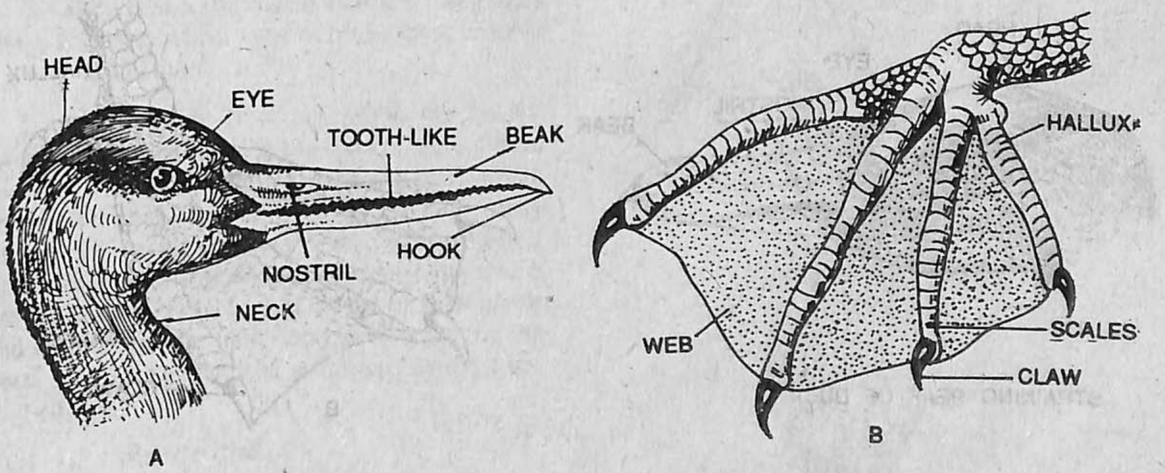


Fig. 3.15.9 Cormorant — A.External Features B. Claw

DUCK (Mallards)

(i) It is also very common in India.

(ii) It lives in water as well as on earth.

(iii) Its body is adapted to water swimming.

(iv) The whole body is covered with feathers which are generally white but may be brown or variegated.

(v) It is insectivorous and generally receives its prey from the mud.

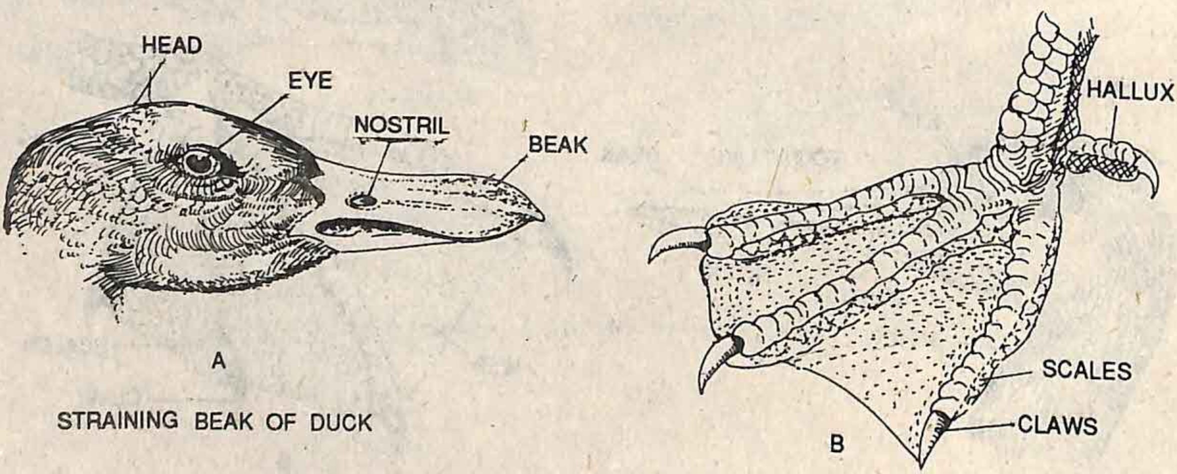
(vi) Its beak is broad and flat and yellow in colour.

(vii) The edges of the jaws are with horny serrations.

(viii) Its beak acts as a sieve or strainer. It can take a large amount of water along with insects and mud in its mouth but as soon as it takes out its beak from the water, it expels water with the help of tongue letting the insect and mud inside the mouth.

(ix) Its feet are also adapted to its living. Each foot is having four toes out of which three toes are webbed and are united with the help of web while the fourth toe is very small and posteriorly arranged.

(x) The tail is small in size.



STRAINING BEAK OF DUCK

Fig 3.15.10 Duck — A. External Features B. Claws

EXPERIMENT 3.16

To identify nests of some common birds like weaver bird, tailor bird etc.

Nest : It is the house of a bird which is built by itself. The following are the aims of making nest.

(i) The bird keeps itself safe from its enemies when it is taking rest.

(ii) It lays eggs safely.

(iii) The nest provides sufficient temperature which is suitable for the development and protecting them from atmospheric adversities.

(iv) The nest is constructed at such a place where the enemies can not reach easily.

(v) Each bird constructs its nest according to its shape and size. Other type of bird cannot enter in the nest of other bird.

Generally pieces of cotton, wool, dry leaves, twigs, rags etc. are used in the construction of nest. Each type of bird constructs nest in its own way in the special shape according to its need. So they identify their nest easily and do not enter in the nest of others. There are several types of nests which are different from each other on the basis of shape and the material specially used in constructing the nest. Out of all types of nests few of them are studied here.

Nest of the Weaver Bird :

(i) The nest of weaver bird looks like a bamboo lantern.

(ii) It is in the hanging position from the branch of the tree.

(iii) The nest is thick in the middle and slenders at both the ends.

(iv) The entrance is from the lower or basal end.

(v) It is very neat and comfortable.

(vi) It is knitted by the bird in such a way that the rain even can not enter into it.

(vii) It is so beautifully knitted with the help of selected thin twigs and leaf petioles that man can not knit it.

(viii) It is hanged in such a way that it swings in the air when wind blows but does not fall down.

(ix) It takes rest in it and also lays eggs there.

(x) The eggs, baby birds and itself in the resting condition are safe from the enemies.

(xi) Through each nest is independently hanged from the branch of the tree but several other similar nests are also there on the same or other branches.

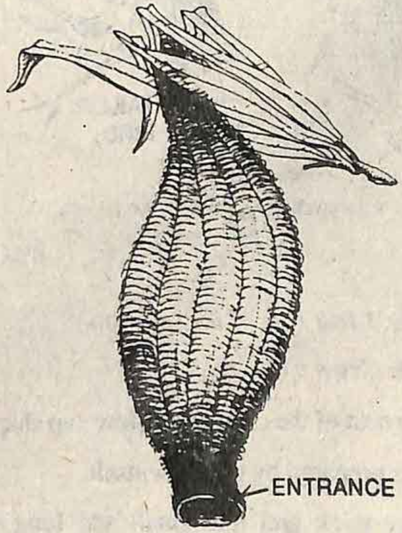


Fig. 3.16.1 Nest of the Weaver Bird

Nest of the Tailor Bird :

(i) The nest of tailor bird is like cucumber in shape.

(ii) It is beautifully prepared by the bird with the help of two or three leaves.

(iii) Bits of cotton, wool, silk etc. are also used in the construction of the nest.

(iv) The nest is cosy inside with grass, cotton, hair and wool.

(v) Generally it is protected outside by a large leaf and is not easily visible by its enemies.

(vi) The nest is sewed by the bird itself with its sharp beak.

(vii) The eggs and baby birds are quite safe in the nest not only from enemies but also from climatic calamities.

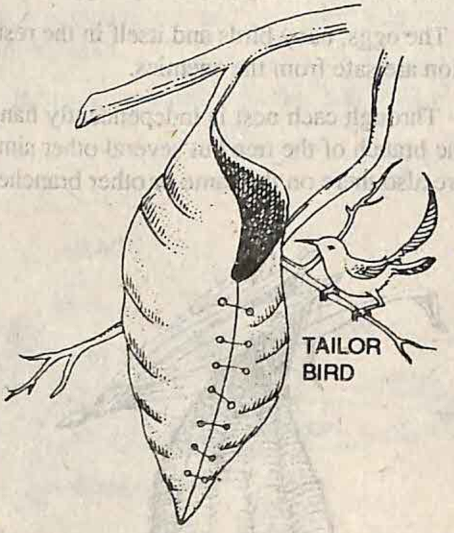


Fig. 3.16.2 Nest of the Tailor Bird

Nest of the Crow :

(i) The nest of the crow is shallow cup shaped.

(ii) It is prepared by the crow itself.

(iii) Dry thick and thin small and long wood sticks, wool rags, wire, lamp coir, thick threads etc. are the common material used in the construction of the nest.

(iv) It is generally prepared at such a place on the tree from where more than two branches arise.

(v) The nest opens upward. The opening is wide.

(vi) The female crow lays eggs there. The eggs are hatched and cared there.

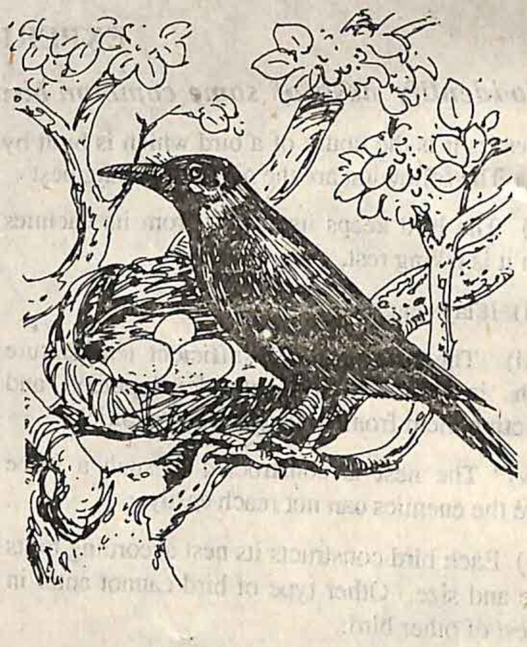


Fig. 3.16.3 Nest of Crow

Nest of the Duck :

(i) Generally the ducks are tamed but the wild ducks construct their nest.

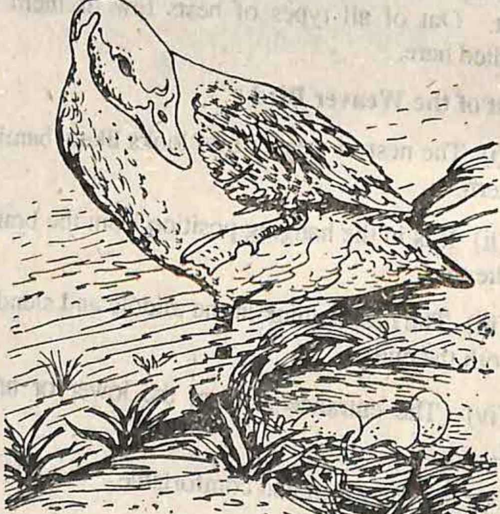


Fig. 3.16.4 Nest of Duck

(ii) The nest is made in the holes of hollow branches of the trees growing near water.

(iii) The hole is thickly lined by grass, feathers. twigs, grasses and leaves.

(iv) The bird lays eggs there. The eggs and the hatched young ones are cared and fed by the parent birds there.

Nest of the Woodpecker :

(i). The nest of the woodpecker is on the tree.

(ii) The nest is constructed by cutting the wood of the thick branches or main stem.

(iii) It is made by the bird itself with the help of its beak.

(iv) The inner lining of the nest is made up of chips of wood.

(v) The eggs are laid in the nest where they are hatched and cared.

(vi) The rainy water does not reach there.

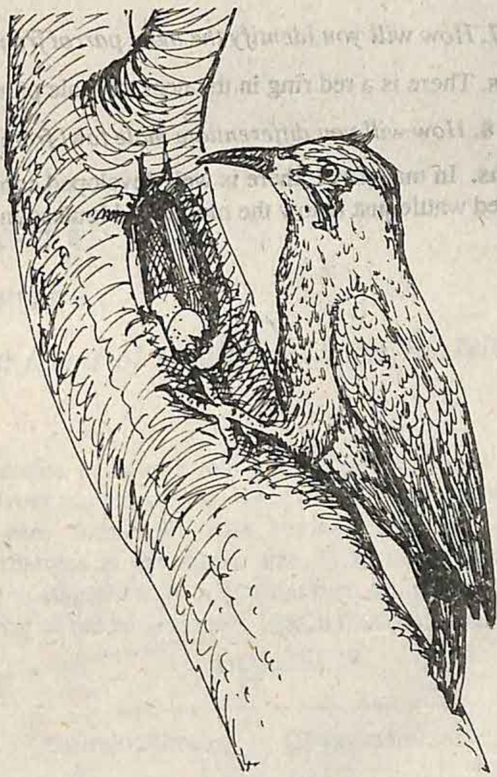


Fig. 3.165 Nest of Woodpecker

ORAL QUESTIONS

Q. 1. *Do all the birds have similar feet ?*

Ans. No, All the birds have no similar feet.

Q. 2. *What is nest ?*

Ans. Nest is the home of bird made of itself.

Q. 3. *What is the utility of nest ?*

Ans. Birds keep their eggs in the nest to protect them from the enemies as well as from the climate. Birds hatch the eggs in the nest.

Q. 4. *Give the name of flightless birds.*

Ans. Flightless birds are Kiwi, Penguin, Emu and Ostrich.

Q. 5. *Where does the pigeon form its nest ?*

Ans. Pigeon forms its nest at the corner just below the roof or any dark and high but safe place.

Q. 6. *What is the shape of the nest of weaver bird ?*

Ans. The nest of weaver bird is flask shaped.

Q. 7. *How will you identify the male parrot from female ?*

Ans. There is a red ring in the neck of male parrot while absent in female parrot.

Q. 8. *How will you differentiate male fowl from female ?*

Ans. In male fowl, there is well developed comb on the head, the tail feathers are bright and long, long bilobed wattle just below the mouth and loud sound,while all these characters are absent in female fowl.

UNIT 4

HUMAN BEINGS

EXPERIMENT 4.1

Identification and comments on ancestral forms of man from charts, models and diagrams.

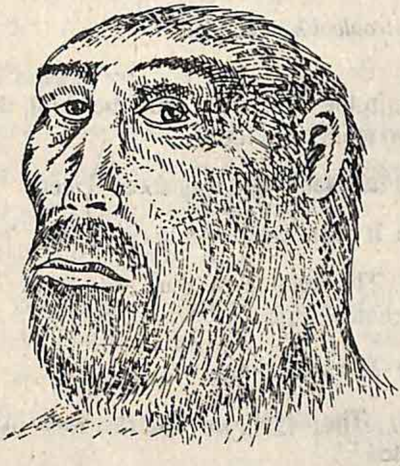


Fig. 4.1.1 Australopithecus africanus (Australopithecine stage)

It has been clear now with the help of discoveries and collections of the parts of skeleton from various parts of the world that the evolution of man took place on earth about one lakh years ago. We could get the knowledge about the evolution of man on the basis of the fossils collected. The early man from which we presume to start the study of evolution of man is called 'HOMINIDS' (Zinjanthropus). Right from this stage till modern man, the skull and the bones of various parts of the body were found from various parts of the world on the basis of which various stages of man could be estimated. These stages were named on the basis of the place where they were found. On the basis of the similarities, changes in the shape, size, behaviour and age, all the stages and forms of the man are placed according to the evolutionary link in the following way :

HOMINIDS

1 (Australopithecus) — 2 (Pithecanthropus erectus)

3 (Homoerectus pekinensis) — 4 (Atlantothropus mauritanicus)

5 (Homo neanderthalensis) — 6 (Cromagnon man)

7 (Homo sapiens)

Main characters of the different forms of man are as follows :

1. Australopithecus :

(i) It is the old fossil relative of man and is commonly called as 'Primitive man'.

(ii) It is very much similar to the chimpanzee of the present time.

(iii) Its body was small in size of about four feet.

(iv) The whole body weight was about 50-60 lbs or 20-30 kgs.

(v) The brain was very small in size.

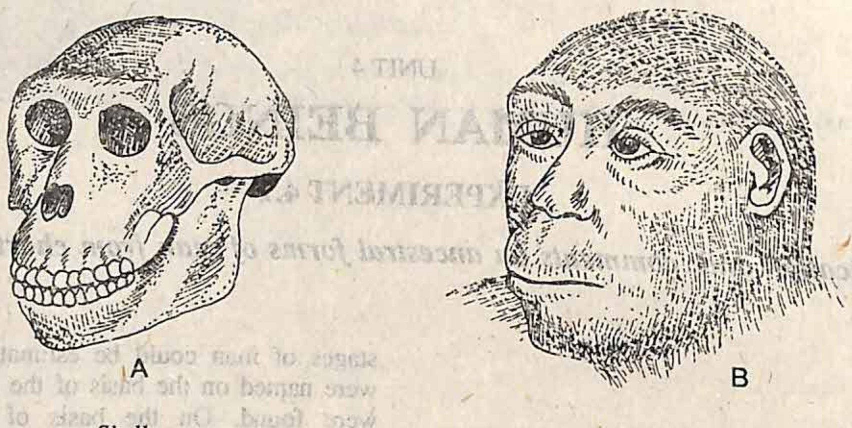


Fig. 4.1.2 *Austalopithecus africans (Austroalopithecine stage)*

(vi) The volume of the skull was about 600 cubic centimetres.

(vii) Probably it walked erectly.

(viii) It had projecting face.

(ix) The molars were big enough.

(x) The canines were short.

2. Pithecanthropus erectus

(i) The fossil was collected from Java. So it is also named as '*Java man*'.

(ii) In the fossil form only the skull, thigh bone and two teeth were found.

(iii) Its total height was about 5 feet.

(iv) It could walk erectly on its feet.

(v) The volume of skull was from 750 - 900 cubic centimetres.

(vi) The skull bones were thick.

(vii) The eyebrow bones were thick and projected.

(viii) The teeth were big in size, heavy and were projected forwardly.

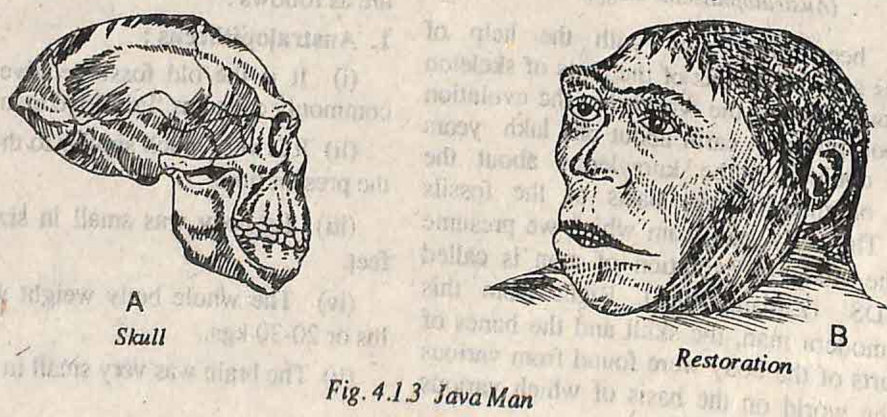
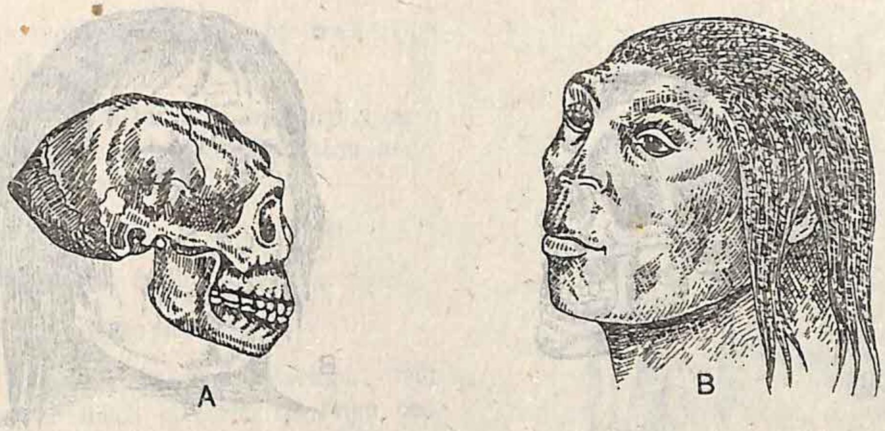


Fig. 4.1.3 Java Man



Skull

Restoration

Fig. 4.1.4 Peking Man

(ix) The lips were also big in size and were projected.

(x) Chin is very less developed.

3. Homo erectus pekinensis :

(i) It was first of all found near Peking (China) so it was also named as 'Peking man'.

(ii) Its skull was very thick.

(iii) The volume of the skull was 900 — 2200 cubic centimetres. So its brain was much developed.

(iv) Its forehead was low and receding.

(v) Its chin was very less developed.

(vi) In the mouth on the jaws canine teeth were large and well developed.

(vii) It was hunter in its habit.

(viii) It utilized fire.

(ix) It also hunted to each other and ate.

4. Atlantothropus mauritanicus :

(i) Three jaws and a parietal bone were found in Algeria (Africa) in 1955 later on some similar fossils were discovered in Morocco and Casa blanca.

(ii) It is similar to Java and Peking man in morphology.

5. Homo neanderthalensis :

(i) It was found in Europe, Asia, North Africa and Germany.

(ii) Its height was about 5 feet.

(iii) The body was stout.

(iv) The brain was well developed.

(v) The skull was thick and stout boned.

(vi) The skull was depressed anteriorly but was protruded posteriorly.

(vii) The forehead was low and sloping but broad and flat.

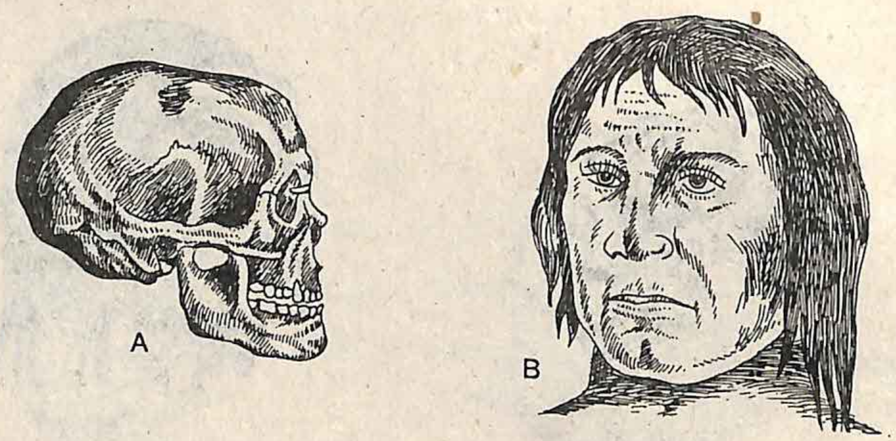
(viii) The brow ridges were heavy.

(ix) The volume of skull cavity was about 1450 cubic centimetres.

(x) The lower jaw was deep.

(xi) The chin was very less developed.

(xii) The neck muscles were very strong.



Skull

Restoration

Fig. 4.1.5 Neanderthal Man

6. Cro-magnon man :

(i) This type of fossils of man was found in France, Italy and other North European countries. It was named on its discovery place Cro-magnon in France.

(ii) This species was more advanced than Neanderthal man.

(iii) Its height was about 6 feet and straight.

(iv) The skull was ~~large~~ and its inner volume was about 1650 cubic centimetres.

(v) The forehead was broad and rounded.

(vi) The brow ridges were absent.

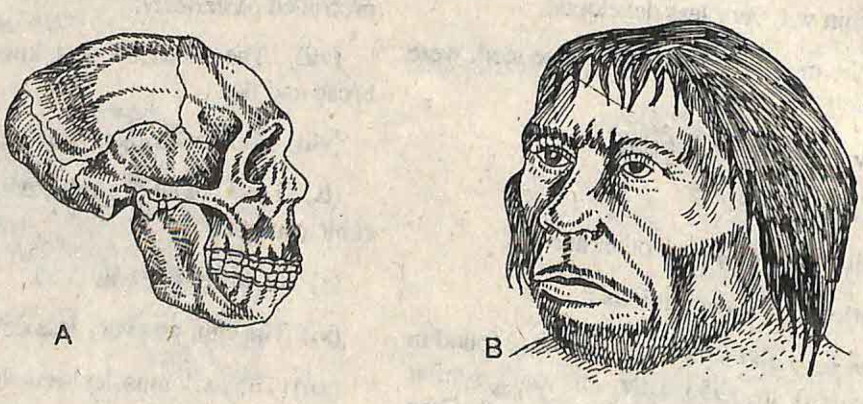
(vii) The nose is protruded and narrow.

(viii) The jaws were thick and strong.

(ix) The chin was narrow and prominent.

7. Homo sapiens :

(i) The fossils of modern man (Homo sapiens) were found in France, Java and South Africa.



Skull

Restoration

Fig. 4.1.6 Cro-Magon (The Modern Stage)

(ii) The present species of man has been living for at least 25,000 years.

(iii) This species includes all the existing races of men like Caucasions, Mongoloids, Australoids, Negroids and Khoisanoids.

(iv) It stands quite erect on both the feet.

(v) Both the hind limbs (legs) are long.

(vi) The forelimbs are erect.

(vii) The brain is well developed and complicated with much enlarged cerebrum and cerebellum.

(viii) The forehead is steep.

(ix) The brow ridges have been very much reduced.

(x) The chin has become prominent.

(xi) The snout has disappeared.

(xii) The speaking organ (tongue) developed.

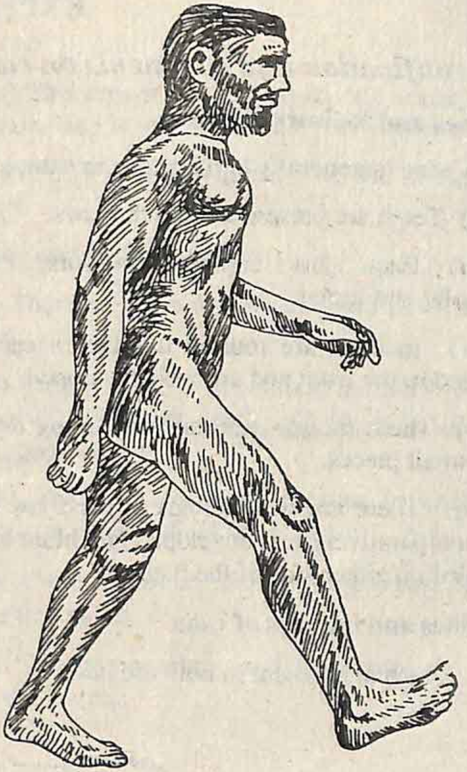


Fig. 4.1.7 Modern Man (Homo sapiens)

ORAL QUESTIONS

Q. 1. *What is the Zoological name of man ?*

Ans. Homo sapiens.

Q. 2. *What is the name of form of man which was presume to evolve first ?*

Ans. The form of man which evolved first was Hominid.

Q. 3. *How can you say that the modern man is more intelligent than their ancestors ?*

Ans. The volume of the skull of modern man is from 1450 to 1500 c.c. while that of Hominid was about 700 c.c. which proves that modern man is more intelligent than his ancestors.

Q. 4. *What is fossil ?*

Ans. The ramenents of organisms preserved in rocks. They are generally hard parts which are partly or completely replaced by minerals.

EXPERIMENT 4.2 (A)

Identification and comments on canines and incisors from actual specimens.

Canines and incisors of man :

(i) Man is generally herbivorous in nature.

(ii) Teeth are present in both the jaws.

(iii) Each jaw contains incisors, canine, premolar and molar.

(iv) Incisors are four in number in each jaw situated in the front and are well developed.

(v) These incisors are used in cutting the food into small pieces.

(vi) There are two canines in each jaw which are comparatively less developed and blunt and are situated on either side of the incisors.

Canines and incisors of Lion :

1. Teeth are present in both the jaws.

2. There are two canines in each jaw.

3. Each canine is well developed and very sharp edged.

4. Incisors are very less developed.

Canines and incisors of Rat :

(i) Teeth are present in both the jaws.

(ii) The incisors are well developed and are four in number in each jaw. They are situated infront of the mouth.

(iii) The canines are two in number in each jaw which are less developed.

(iv) The incisors are sharply edged.

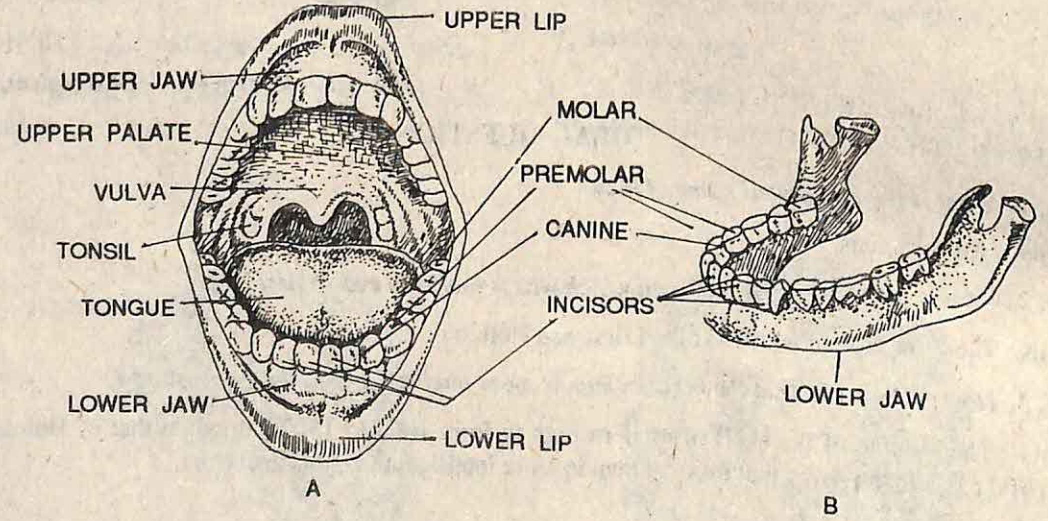


Fig. 4.2(A) A. Human Buccal Cavity B. Lower Jaw of Human

EXPERIMENT 4.2 (B)

Structure of Tooth of Man.

(i) The human tooth is divided into three main parts i.e. (a) Crown (b) Neck and (c) Root.

(ii) The tooth has a cavity in the centre known as pulp cavity.

(iii) The pulp cavity is filled with a viscus liquid known as 'pulp'.

(iv) Blood capillaries and nerves sink in this pulp.

(v) The pulp cavity is bounded by a hard covering known as 'DENTINE'.

(vi) Dentine is covered with cement with the help of which the tooth is tightly attached with the bone of jaw.

(vii) The neck of the tooth is covered by gum of the jaw. It is the short part of a tooth.

(viii) The crown of the tooth is that part which is situated just above the gum.

(ix) This crown part is also having some part of dentine which is externally covered with enamel.

(x) Crown part is white due to the presence of enamel.

Canine and incisors of Dog :

(i) There are teeth in both the jaws in the buccal cavity.

(ii) Though each jaw contains incisors, canine, premolar and molar teeth but incisors are less developed.

(iii) There is a pair of canines in each jaw situated on either side of the incisors.

(iv) Canine teeth are well developed and pointed with sharp edges.

(v) The canines are used in tearing the flesh from the bones.

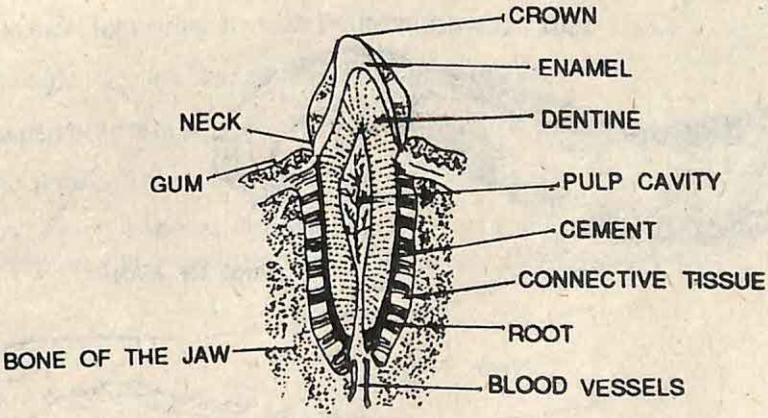


Fig. 4.2(B) Internal structure of a tooth (canine)

EXPERIMENT 4.3

Identification and comments upon the structure of hand of monkey and man.

Keeping in view the evolution of man it becomes clear that man and monkeys are evolved from the same stalk due to the resemblance of the body organs. Though the hands of man and monkey are very much similar in structure and functions even then they are dissimilar upto some extent.

Structure of Monkey's (Marmosoid's) hand :

(i) The hand includes wrist, palm and fingers.

(ii) Palm is small in size comparatively to the length of the fingers.

(iii) The fingers are long cylindrical having long metacarpals.

(iv) The distal free end of each finger is a claw which possesses a nail on the dorsal side.

(v) The metacarpals are loosely attached.

(vi) The thumb is shorter than the fingers.

(vii) The thumb is also parallely placed to the fingers facing in the same direction.

Structure of the hand of Man (Homo sapiens) :

(i) The hand of man also includes the wrist, palm and fingers.

(ii) The wrist is made up of 8 carpals which are arranged in two rows. Four carpals in each row.

(iii) There are four fingers and one thumb.

(iv) The palm is made up of carpals.

(v) All the four fingers have matacarpals and claws and a nail dorsally placed.

(vi) The thumb is shorter than the other fingers.

(vii) The thumb is displaced at right angle to the other fingers which helps in gripping the things.

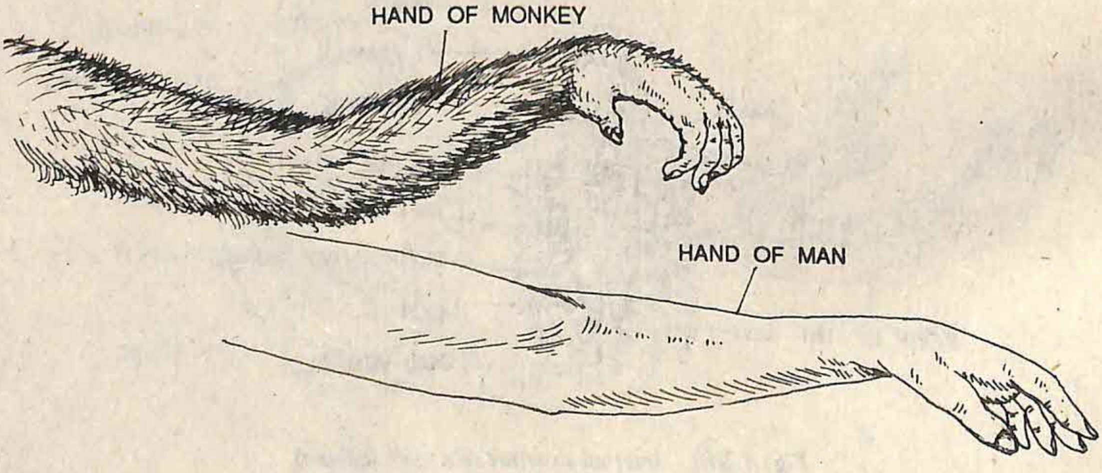


Fig. 4.3.1 Hand of monkey and man

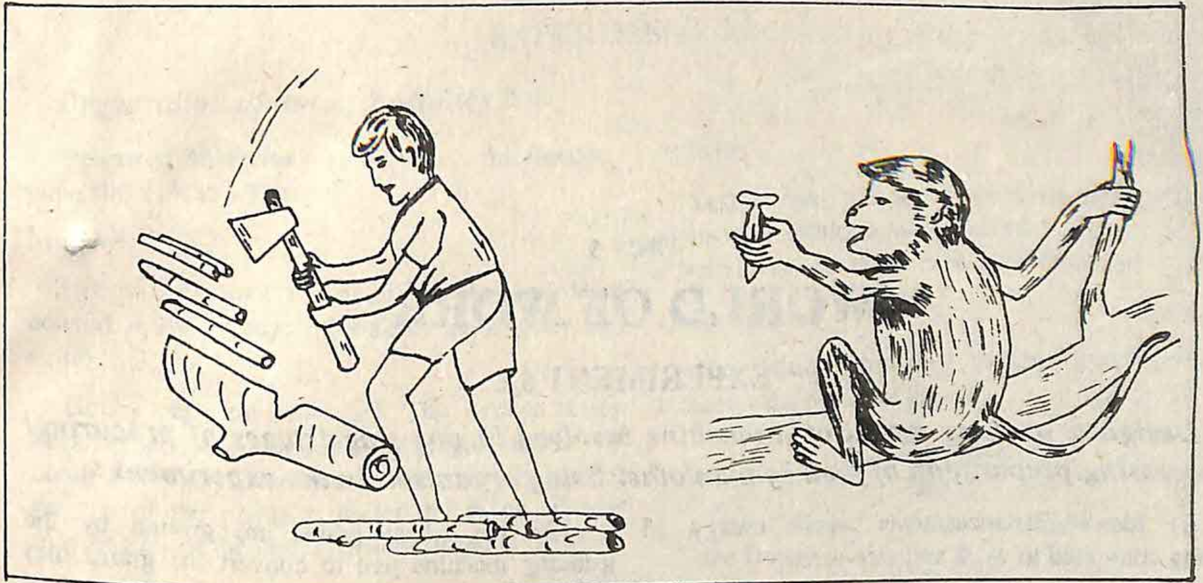


Fig. 4.3.2 Hand of man and monkey in action

ORAL QUESTIONS

Q. 1. *How many incisor teeth are present in both the jaws of man ?*

Ans. There are eight incisors (four in each jaw) in the buccal cavity of man.

Q. 2. *What is the function of canine ?*

Ans. Canines are ment for tearing the flesh from the bones.

Q. 3. *What is the difference in shape of incisor and of canine ?*

Ans. The crown part of incisor is broad while that of canine is pointed sharp edged and stout.

Q. 4. *What is the main difference in the thumb of man and monkey ?*

Ans. The thumb of man is shorter than the fingers and is facing at right angle to the fingers while in monkey the thumb is shorter than the fingers but is parallel to other fingers.

UNIT 5

WORLD OF WORK

EXPERIMENT 5.1

Design a working model of a machine involved in any stage/stages of procuring/ processing/preparation of food by man/other living organism. In the experiment :

(i) Identify/instances/areas where energy is being converted to work and *vice-versa*.

(ii) Identify/recognize the form of work being performed.

(iii) Co-relate the scientific laws involved in the inter-conversions.

Required Material :

Threshing machine, Grinding machine, Chulha, wheat plants, Utensils.

Method :

The process of changing raw food materials into a more readily usable form is called food-processing.

Procedure :

Take the wheat plants, put them into the threshing machine. This machine is run by electricity. It separate the grains from other parts of the plants.

Now the wheat grains are ground by the grinding machine just to convert the grains into flour. Electric energy is used in this process. The wheat flour is converted into semi solid paste and then chapaties are prepared. The fire energy is used in this process. In the above mentioned steps of process physical change takes place while the chemical change takes place in the conversion of flour into chapaties.*

Result :

The above experiment shows the processing of wheat into chapaties.

(i) Electricity is used in the conversion of Grains into flour and heat from fire energy is used in the conversion of flour into chapaties.

(ii) $\text{Grain} \xrightarrow[\text{Physcial change}]{} \text{Flour} \xrightarrow[\text{chemcial change}]{} \text{Chapaties}$

---

* Students can write about the processing of ice upto idli form and can take help from the teacher, friends or parents.

EXPERIMENT 5.2

Preparation of honey by honey bee.

Required Material : Honey bee, microscope, plain slide, clean water.

Method :

Honey bees suck the nectar of flowers. They convert it into honey and wax to form honey bee comb.

Honey bees are unisexual. The worker honey bees are sterile in nature. They prepare the honey comb and honey. Honey comb is generally seen at the top of the plants protected by twigs. Combs may be seen at the upper partions of the buildings.

Procedure :

Honey is the converted form of nectar of the flowers which is formed by the biochemical change in the body of honey bee.

Test 1. Honey is pure and natural or artificial. It can be tested as under —

Test 1.1 Pour the honey in the stand still water in a glass.

Observation :

The honey does not mix with the water. It showes its purity. If it dissolves in water, it is artificial.

Test 2. Take a drop of honey on clean and dry plain slide. Make a thin film of it. Cover it with cover slip and examine it under microscope.

Observation :

The honey contains pollen grains which indicates the purity of honey.

$$\text{Nectar of the flower} \xrightarrow[\text{Chemical change}]{\text{Biochemical energy}} \text{Honey}$$

Result :

The above experiment shows that—

(i) Honey is prepared by honey bee (insects).

(ii) Honey is identified by simple tests.

(iii) Biochemical energy produced in the metabolic activities in the body of honey bee is utilized in the conversion of nectar into honey.

(iv) In this process chemical change takes place.

ORAL QUESTIONS

Q. 1. *What do you mean by procuring ?*

Ans. Procuring means to keep the food material safe for future.

Q. 2. *What is processing ?*

Ans. The process of changing raw food materials into a more readily usable form is called food processing.

Q. 3. *How many types of energy you know ? Give names only.*

Ans. There are 8 types of energy. They are as follows: 1. Heat energy. 2. Water energy (Hydro power). 3. Coal energy (Thermal energy). 4. Solar energy. 5. Magnetic energy. 6. Muscular energy. 7. Atmoic energy. 8. Sound energy.

Q. 4. *How can you say that the provided honey is pure ?*

Ans. Honey is tested by pouring it in the stand still water. If it does not dissolve, it is pure otherwise mpure. It can be tested by examining the thin film under microscope. If the film of the honey contains pollengrains, it is pure otherwise impure.

Q. 5. *When the fruit is riped, what type of change do you find ?*

Ans. In the ripening of fruit the chemical change takes place.

Q. 6. *Where do you find the honey ?*

Ans. Honey is obtained from honey comb.

Q. 7. *Can man prepare any food ?*

Ans. No. He can modify the form of food already prepared by plants or any other animal.

Q. 8. *What type of energy is utilized by insect (Honey bee) in the preparation of honey ?*

Ans. Biochemical energy.

EXPERIMENT 5.3

To design a model of "Integrated Rural Development, their energy needs, new technologies and essential services management".

Procedure :

The power of the wind and the solar heat can be used in many ways in integrated rural development and for their energy needs. The models can include the following :

1. Solar cooker for domestic and community cooking.
2. Improved wood stoves for domestic cooking which saves about 30-40% energy.
3. Solar Geysers for domestic and individual water heating.
4. Solar Photovoltaics (SPV) for street lighting.
5. Solar Thermal Pump for deep water pumping for irrigation.
6. Wind Mills for pumping water for drinking and irrigation.
7. Aero Generators for electricity generation.
8. Biogas Plants for domestic cooking, lighting and manure.
9. Photovoltaics Power house for electricity generation from solar PV.
10. Stiling Engine - Electricity generation from wastes.

All these innovations are already installed in 35 villages in different parts of the country as rural energy parks. One of such energy park is shown in fig. 5.3.1. All innovations are installed at a common place in a village to make supply of integrated package of energy. In addition other 34 villages are being prepared for rural energy parks. One can prepare an integrated model of above items with the help of local government bodies.

From the model the students can understand that there is a need for change in technology. We do not need to depend upon traditional method of using wood and dung in solid form as a fuel for cooking which cause pollution and its smoke effects the lungs of the person cooking. Nor do we have to depend upon the power house generated electricity for lighting purposes.

Conclusion :

These new innovations and technology involved in them bring a new era of very low cost energy which is derived from solar energy, winds, dung of animals and waste materials. This new technology does not produce any pollution in air, water etc.

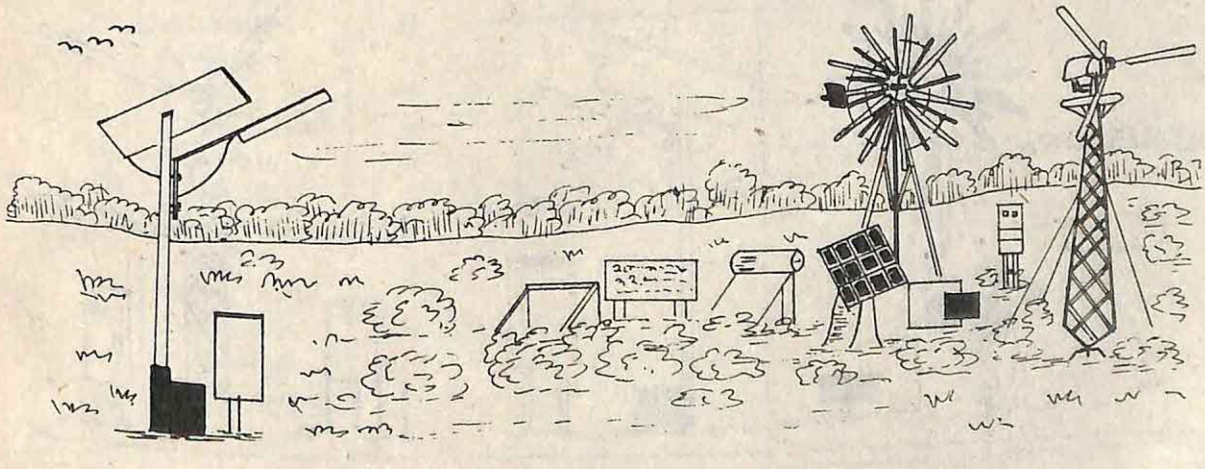
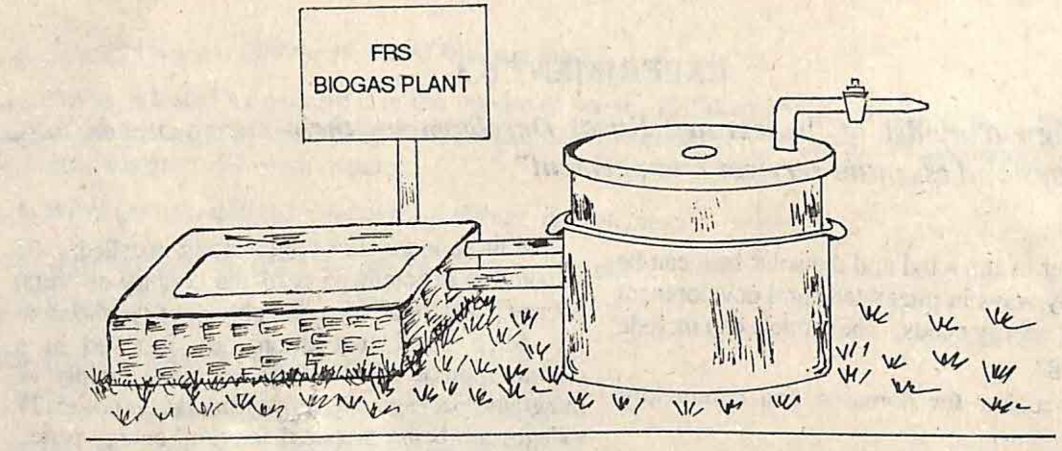
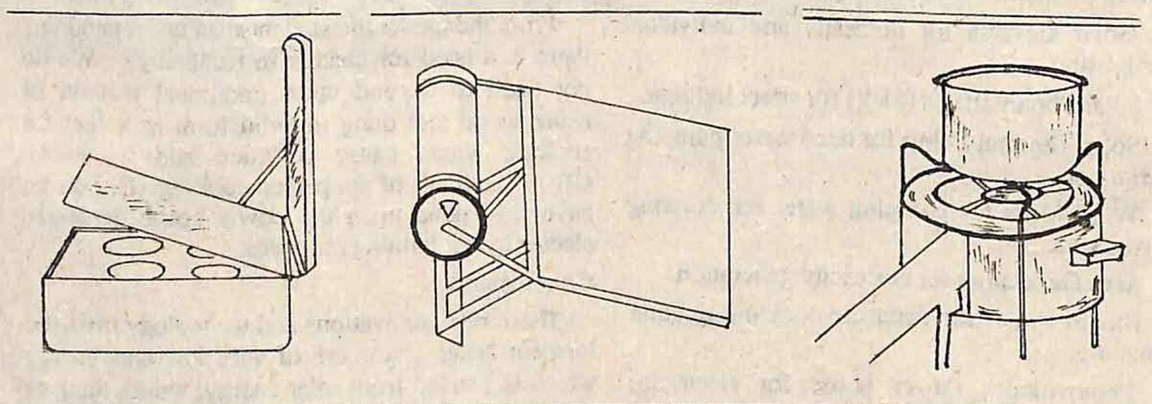


Fig. 5.3.1. An energy park set up in rural Delhi



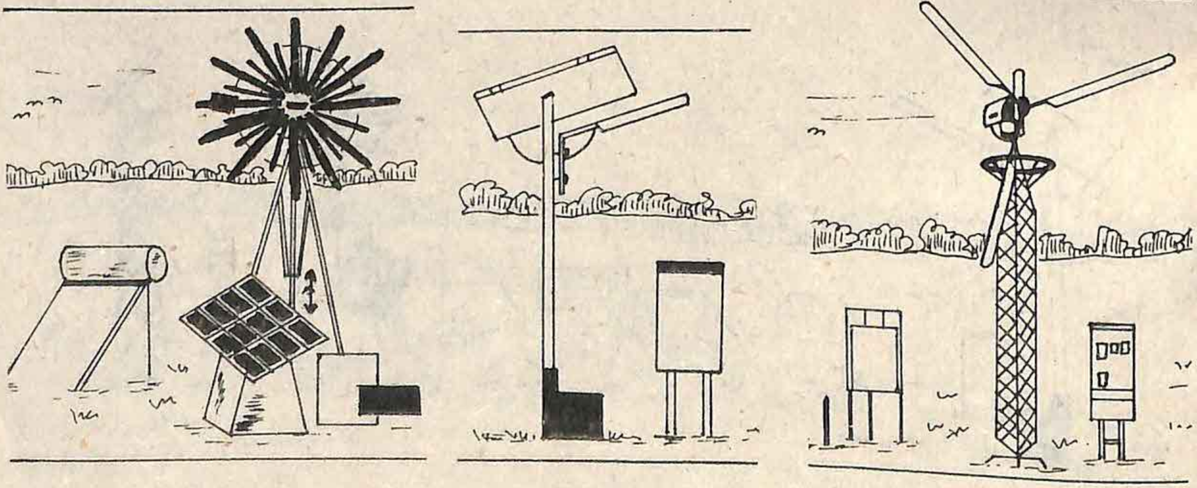
BIOGAS PLANT



SOLAR COOKER

SOLAR GEYSER

WOOD STOVE



WIND MILL

PV LIGHT

AERO GENERATOR

Fig. 5.3.2 Models based on the uses of different forms of energy

APPENDIX I

Symbols and the units of physical quantities

S. No.	*Physical Quantity*	*Symbol*	*Units*		*Relation between units*
			C.G.S. System	*M. K. S. System*	
1.	Distance or Length	l or s	Centimetre	metre	1 metre = 100 cm
2.	Area	A	Square centimetre	Square metre	1 sq. m. = 10^4 sq.cm
3.	Volume	V	Cubic centimetre	Cubic metre	1 $m^3 = 10^6$ cm^3 (C.C.)
4.	Mass	m	gramme	Kilogramme	1 kg = 10^3 g
5.	Time	t	Second	Second	
6.	Velocity	V_i, V_f, V	cm/second	metre/$second^2$	
7.	Acceleration	a	cm/$second^2$		
8.	Force	F	dyne or g wt.	Newton or kg. wt.	1 kg wt. = 9·81 Newton 1 gm wt. = 981 dyne
9.	Momentum	M	g cm/sec.	kg. m/sec	
10.	Moment	M	dyne-*cm*	Newton-*m*	1 Newton = 10^5 dyne
11.	Pressure	P	dyne.α/sq. cm	Newton/sq. *m*	
12.	Work	W	erg	Joule	
13.	Energy	E	erg	Joule	1 Joule = 10^7 erg
14.	Power	P	erg/sec.	Joule/sec. or watt	1 H.P. = 746 watt
15.	Heat	H	Calorie	Kilo calorie	
16.	Temperature	θ	°C	K	
17.	Acceleration due to gravity	g	981 cm/sec^2	9·81 m/sec^2	
18.	Gravitational constatnt	G	6.67×10^{-8} dyne cm^2/g^2	6.67×10^{-11} Newton m^2/kg^2	
19.	Horizontal component of earth's magnetic field	H	.32 oersted	.32 oersted	
20.	Frequency	n	Hertz	Kilo Hertz	
21.	Focal length	f	cm	m	
22.	Distance of object from lens or mirror	u	cm	m	
23.	Distance of image from lens or mirror	v	cm	m	
24.	Power of lens	P		Diopter	

APPENDIX II

Few Inventions and their Inventors

Inventions	*Inventor*	*Inventions*	*Inventor*
1. Electric current	Loi Galvani	13. Telescope	Galelio
2. Electric cell	Volta	14. Atom bomb	Autohon
3. Telegraph	Morse	15. Aeroplane	Wright Brothers
4. Telephone	Grahm Bell	16. Submarine	Brush Bell
5. Television	J.L.Baird	17. Laws of motion	Newton
6. Transistor	William Shonkhle	18. Laws of gravitation	Newton
7. Dynamo	Faraday	19. Falling of bodies	Galelio
8. X-rays	Roentgen	20. Law of floatation	Archimedes
9. Electric bulb	Edison	21. Law of transmission of pressure in liquids	Pascal
10. Radar	Robert Watt	22. Law of elasticity	Robert Hook
11. Steam Engine	James Watt	23. Law of gas pressure	Boyle
12. Thermos Flask	Dewar	24. Law of gas volume	Charles

APPENDIX III

Refractive Index

1. Crown glass	1.5170
2. Flint glass	1.6499
3. Diamond	2.42
4. Turpentine oil	1.47
5. Water	1.33
6. Ice	1.31
7. Olive oil	1.47
8. Ethyl alcohol	1.36
9. Glycerine	1.47
10. Kerosene oil	1.39

APPENDIX IV

Natural Sines

Degrees	0 0°.0	6′ 0°.1	12′ 0°.2	18′ 0°.3	24′ 0°.4	30′ 0°.5	36′ 0°.6	42′ 0°.7	48′ 0°.8	54′ 0°.9	Mean Differences				
											1	2	3	4	5
0	·0000	0017	0035	0052	0070	0087	0105	0122	0140	0157	3	6	9	12	15
1	·0175	0192	0209	0227	0244	0262	0279	0297	0314	0332	3	6	9	12	15
2	·0349	0366	0384	0401	0419	0436	0454	0471	0488	0506	3	6	9	12	15
3	·0523	0541	0558	0576	0593	0610	0628	0645	0663	0680	3	6	9	12	15
4	·0698	0715	0732	0750	0767	0785	0802	0819	0837	0854	3	6	9	12	15
5	·0872	0889	0906	0924	0941	0958	0976	0993	1011	1028	3	6	9	12	14
6	·1045	1063	1080	1097	1115	1132	1149	1167	1184	1201	3	6	9	12	14
7	·1219	1236	1253	1271	1288	1305	1323	1340	1357	1374	3	6	9	12	14
8	·1392	1409	1426	1444	1461	1478	1495	1513	1530	1547	3	6	9	12	14
9	·1564	1582	1599	1616	1633	1650	1668	1685	1702	1719	3	6	9	12	14
10	·1736	1754	1771	1788	1805	1822	1840	1857	1874	1891	3	6	9	12	14
11	·1908	1925	1942	1959	1977	1994	2011	2028	2045	2062	3	6	9	11	14
12	·2079	2096	2113	2130	2147	2164	2181	2198	2215	2232	3	6	9	11	14
13	·2250	2267	2284	2300	2317	2334	2351	2368	2385	2402	3	6	8	11	14
14	·2419	2436	2453	2470	2487	2504	2521	2538	2554	2571	3	6	8	11	14
15	·2588	2605	2622	2639	2656	2672	2689	2706	2723	2740	3	6	8	11	14
16	·2756	2773	2790	2807	2823	2840	2857	2874	2890	2907	3	6	8	11	14
17	·2924	2940	2957	2974	2990	3007	3024	3040	3057	3074	3	6	8	11	14
18	·3090	3107	3123	3140	3156	3173	3190	3206	3223	3239	3	6	8	11	14
19	·3256	3272	3289	3305	3322	3338	3355	3371	3387	3404	3	5	8	11	14
20	·3420	3437	3453	3469	3486	3502	3518	3535	3551	3567	3	5	8	11	14
21	·3584	3600	3616	3633	3649	3665	3681	3697	3714	3730	3	5	8	11	14
22	·3746	3762	3778	3795	3811	3827	3843	3859	3875	3891	3	5	8	11	14
23	·3907	3923	3939	3955	3971	3987	4003	4019	4035	4051	3	5	8	11	14
24	·4067	4083	4099	4115	4131	4147	4163	4179	4195	4210	3	5	8	11	13
25	·4226	4242	4258	4274	4289	4305	4321	4337	4352	4368	3	5	8	11	13
26	·4384	4399	4415	4431	4446	4462	4478	4493	4509	4524	3	5	8	10	13
27	·4540	4555	4571	4586	4602	4617	4633	4648	4664	4679	3	5	8	10	13
28	·4695	4710	4726	4741	4756	4772	4787	4802	4818	4833	3	5	8	10	13
29	·4848	4863	4879	4894	4909	4924	4939	4955	4970	4985	3	5	8	10	13
30	·5000	5015	5030	5045	5060	5075	5090	5105	5120	5135	3	5	8	10	13
31	·5150	5165	5180	5195	5210	5225	5240	5255	5270	5284	2	5	7	10	12
32	·5299	5314	5329	5344	5358	5373	5388	5402	5417	5432	2	5	7	10	12
33	·5446	5461	5476	5490	5505	5519	5534	5548	5563	5577	2	5	7	10	12
34	·5592	5606	5621	5635	5650	5664	5678	5693	5707	5721	2	5	7	10	12
35	·5736	5750	5764	5779	5793	5807	5821	5835	5850	5864	2	5	7	10	12
36	·5878	5892	5906	5920	5934	5948	5962	5976	5990	6004	2	5	7	9	12
37	·6018	6032	6046	6060	6074	6088	6101	6115	6129	6143	2	5	7	9	12
38	·6157	6170	6184	6198	6211	6225	6239	6252	6266	6280	2	5	7	9	11
39	·6293	6307	6320	6334	6347	6361	6374	6388	6401	6414	2	4	7	9	11
40	·6428	6441	6455	6468	6481	6494	6508	6521	6534	6547	2	4	7	9	11
41	·6561	6574	6587	6600	6613	6626	6639	6652	6665	6678	2	4	7	9	11
42	·6691	6704	6717	6730	6743	6756	6769	6782	6794	6807	2	4	6	9	11
43	·6820	6833	6845	6858	6871	6884	6896	6909	6921	6934	2	4	6	8	11
44	·6947	6959	6972	6984	6997	7009	7022	7034	7046	7059	2	4	6	8	10

NATURAL SINES

Degrees	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′	Mean Differences				
	0°.0	0°.1	0°.2	0°.3	0°.4	0°.5	0°.6	0°.7	0°.8	0°.9	1	2	3	4	5
45	·7071	7083	7096	7108	7120	7133	7145	7157	7169	7181	2	4	6	8	10
46	·7193	7206	7218	7230	7242	7254	7266	7278	7290	7302	2	4	6	8	10
47	·7314	7325	7337	7349	7361	7373	7385	7396	7408	7420	2	4	6	8	10
48	·7431	7443	7455	7466	7478	7490	7501	7513	7524	7536	2	4	6	8	10
49	·7547	7558	7570	7581	7593	7604	7615	7627	7638	7649	2	4	6	8	9
50	·7660	7672	7683	7694	7705	7716	7727	7738	7749	7760	2	4	6	7	9
51	·7771	7782	7793	7804	7815	7826	7837	7848	7859	7869	2	4	5	7	9
52	·7880.	7891	7902	7912	7923	7934	7944	7955	7965	7976	2	4	5	7	9
53	·7986	7997	8007	8018	8028	8039	8049	8059	8070	8080	2	3	5	7	9
54	·8090	8100	8111	8121	8131	8141	8151	8161	8171	8181	2	3	5	7	8
55	·8192	8202	8211	8221	8231	8241	8251	8261	8271	8281	2	3	5	7	8
56	·8290	8300	8310	8320	8329	8339	8348	8358	8368	8377	2	3	5	6	8
57	·8387	8396	8406	8415	8425	8434	8443	8453	8462	8471	2	3	5	6	8
58	·8480	8490	8499	8508	8517	8526	8536	8545	8554	8563	2	3	5	6	8
59	·8572	8581	8590	8599	8607	8616	8625	8634	8643	8652	1	3	4	6	7
60	·8660	8669	8678	8686	8695	8704	8712	8721	8729	8738	1	3	4	6	7
61	·8746	8755	8763	8771	8780	8788	8796	8805	8813	8821	1	3	4	6	7
62	·8829	8838	8846	8854	8862	8870	8878	8886	8894	8902	1	3	4	5	7
63	·8910	8918	8926	8934	8942	8949	8957	8965	8973	8980	1	3	4	5	6
64	·8988	8996	9003	9011	9018	9026	9033	9041	9048	9056	1	3	4	5	6
65	·9063	9070	9078	9085	9092	9100	9107	9114	9121	9128	1	2	4	5	6
66	·9135	9143	9150	9157	9164	9171	9178	9184	9191	9198	1	2	3	5	6
67	·9205	9212	9219	9225	9232	9239	9245	9252	9259	9265	1	2	3	4	6
68	·9272	9278	9285	9291	9298	9304	9311	9317	9323	9330	1	2	3	4	5
69	·9336	9342	9348	9354	9361	9367	9373	9379	9385	9391	1	2	3	4	5
70	·9397	9403	9409	9415	9421	9426	9432	9438	9444	9449	1	2	3	4	5
71	·9455	9461	9466	9472	9478	9483	9489	9494	9500	9505	1	2	3	4	5
72	·9511	9516	9521	9527	9532	9537	9542	9548	9553	9558	1	2	3	3	4
73	·9563	9568	9573	9578	9583	9588	9593	9598	9603	9608	1	2	2	3	4
74	·9613	9617	9622	9627	9632	9636	9641	9646	9650	9655	1	2	2	3	4
75	·9659	9664	9668	9673	9677	9681	9686	9690	9694	9699	1	1	2	3	4
76	·9703	9707	9711	9715	9720	9724	9728	9732	9736	9740	1	1	2	3	3
77	·9744	9748	9751	9755	9759	9763	9767	9770	9774	9778	1	1	2	3	3
78	·9781	9785	9789	9792	9796	9799	9803	9806	9810	9813	1	1	2	2	3
79	·9816	9820	9823	9826	9829	9833	9836	9839	9842	9845	1	1	2	2	3
80	·9848	9851	9854	9857	9860	9863	9866	9869	9871	9874	0	1	1	2	2
81	·9877	9880	9882	9885	9888	9890	9893	9895	9898	9900	0	1	1	2	2
82	·9903	9905	9907	9910	9912	9914	9917	9919	9921	9923	0	1	1	2	2
83	·9925	9928	9930	9932	9934	9936	9938	9940	9942	9943	0	1	1	1	2
84	·9945	9947	9949	9951	9952	8854	9956	9957	9959	9960	0	1	1	1	2
85	·9962	9963	9965	9966	9968	9969	9971	9972	9973	9974	0	0	1	1	1
86	·9976	9977	9978	9979	9980	9981	9982	9983	9984	9985	0	0	1	1	1
87	·9986	9987	9988	9989	9990	9990	9991	9992	9993	9993	0	0	0	1	1
88	·9994	9995	9995	9996	9996	9997	9997	9997	9998	9998	0	0	0	0	0
89	·9998	9999	9999	9999	9999	1.000	1.000	1.000	1.000	1.000	0	0	0	0	0
90	1·000														

APPENDIX V

Powers, Roots and Reciprocals

n	n^2	n^3	$\sqrt{n}$	$\sqrt[3]{n}$	$\sqrt{10n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$1/n$
1	1	1	1	1	3·162	2·154	4·642	1
2	4	8	1·414	1·260	4·472	2·714	5·848	·5000
3	9	27	1·732	1·442	5·477	3·107	6·694	·3333
4	16	64	2	1·587	6·325	3·420	7·368	·2500
5	25	125	2·236	1·710	7·071	3·684	7·937	·2000
6	36	216	2·449	1·817	7·746	3·915	8·434	·1667
7	49	343	2·646	1·913	8·367	4·121	8·879	·1429
8	64	512	2·828	2·000	8·944	4·309	9·283	·1250
9	81	729	3·000	2·080	9·487	4·481	9·655	·1111
10	100	1000	3·162	2·154	10·0	4·642	10·000	·1000
11	121	1331	3·317	2·224	10·488	4·791	10·323	·09091
12	144	1728	3·464	2·289	10·954	4·932	10·627	·08333
13	169	2197	3·606	2·351	11·402	5·066	10·914	·07692
14	196	2744	3·742	2·410	11·832	5·192	11·187	·07143
15	225	3375	3·873	2·466	12·247	5·313	11·447	·06667
16	256	4096	4·000	2·520	12·649	5·429	11·696	·06250
17	289	4913	4·123	2·571	13·038	5·540	11·935	·05882
18	324	5832	4·243	2·621	13·416	5·646	12·164	·05556
19	361	6859	4·359	2·668	13·784	5·749	12·386	·05263
20	400	8000	4·472	2·714	14·142	5·848	12·599	·0500
21	441	9261	4·583	2·759	14·491	5·944	12·806	·04762
22	484	10648	4·690	2·802	14·832	6·037	13·006	·04545
23	529	12167	4·796	2·844	15·166	6·127	13·200	·04348
24	576	13824	4·899	2·884	15·492	6·214	13·389	·04167
25	625	15625	5·000	2·924	15·811	6·300	13·572	·0400
26	676	17576	5·099	2·962	16·125	6·383	13·751	·03846
27	729	19683	5·196	3·000	16·432	6·463	13·925	·03704
28	784	21952	5·292	3·037	16·733	6·542	14·095	·03571
29	841	24389	5·385	3·072	17·029	6·619	14·260	·03448
30	900	27000	5·477	3·107	17·321	6·694	14·422	·03333
31	961	29791	5·568	3·141	17·607	6·768	14·581	·03226
32	1024	32768	5·657	3·175	17·889	6·840	14·736	·03125
33	1089	35937	5·745	3·208	18·166	6·910	14·888	·03030
34	1156	39304	5·831	3·240	18·439	6·980	15·037	·02941
35	1225	42875	5·916	3·271	18·708	7·047	15·183	·02857
36	1296	46656	6·000	3·302	18·974	7·114	15·326	·02778
37	1369	50653	6·083	3·332	19·235	7·179	15·467	·02703
38	1444	54872	6·164	3·362	19·494	7·243	15·605	·02632
39	1521	59319	6·245	3·391	19·748	7·306	15·741	·02564
40	1600	64000	6·325	3·420	20·00	7·368	15·874	·0250
41	1681	68921	6·403	3·448	20·248	7·429	16·005	·02439
42	1764	74088	6·481	3·476	20·494	7·489	16·134	·02381
43	1849	79507	6·557	3·503	20·736	7·548	16·261	·02326
44	1936	85184	6·633	3·530	20·976	7·606	16·386	·02273
45	2025	91125	6·708	3·557	21·213	7·663	16·510	·02222
46	2116	97336	6·782	3·583	21·448	7·719	16·631	·02174
47	2209	103823	6·856	3·609	21·679	7·775	16·751	·02128
48	2304	110592	6·928	3·634	21·909	7·830	16·869	·02083
49	2401	117649	7·000	3·659	22·136	7·884	16·985	·02041
50	2500	125000	7·071	3·684	22·361	7·937	17·100	·020

APPENDIX V

Powers, Roots and Reciprocals

n	n^2	n^3	$\sqrt{n}$	$\sqrt[3]{n}$	$\sqrt{10n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$1/n$
51	2601	132651	7.141	3.708	22.583	7.990	17.213	.01961
52	2704	140608	7.211	3.733	22.804	8.041	17.325	.01923
53	2809	148877	7.280	3.756	23.022	8.093	17.435	.01887
54	2916	157464	7.348	3.780	23.238	8.143	17.544	.01852
55	3025	166375	7.416	3.803	23.452	8.193	17.652	.01818
56	3136	175616	7.483	3.826	23.664	8.243	17.758	.01786
57	3249	185193	7.550	3.849	23.875	8.291	17.863	.01754
58	3364	195112	7.616	3.871	24.083	8.340	17.967	.01724
59	3481	205379	7.681	3.893	24.290	8.387	18.071	.01695
60	3600	216000	7.746	3.915	24.495	8.434	18.171	.01667
61	3721	226981	7.810	3.936	24.698	8.481	18.272	.01639
62	3844	238328	7.874	3.958	24.900	8.527	18.371	.01613
63	3969	250047	7.937	3.979	25.100	8.573	18.469	.01587
64	4096	262144	8.000	4.000	25.298	8.618	18.566	.01562
65	4225	274625	8.062	4.021	25.495	8.662	18.663	.01538
66	4356	287496	8.124	4.041	25.690	8.707	18.758	.01515
67	4489	300763	8.185	4.062	25.884	8.750	18.852	.01493
68	4624	314432	8.246	4.082	26.077	8.794	18.945	.01471
69	4761	328509	8.307	4.102	26.268	8.837	19.038	.01449
70	4900	343000	8.367	4.121	26.458	8.879	19.129	.01429
71	5041	357911	8.426	4.141	26.646	8.921	19.220	.01408
72	5184	373248	8.485	4.160	26.833	8.963	19.310	.01389
73	5329	389017	8.544	4.179	27.019	9.004	19.399	.01370
74	5476	405224	8.602	4.198	27.203	9.045	19.487	.01351
75	5625	421875	8.660	4.217	27.386	9.086	19.574	.01333
76	5776	438976	8.718	4.236	27.568	9.126	19.661	.01316
77	5929	456533	8.775	4.254	27.749	9.166	19.747	.01299
78	6084	474552	8.832	4.273	27.928	9.205	19.832	.01282
79	6241	493039	8.888	4.291	28.107	9.244	19.916	.01266
80	6400	512000	8.944	4.309	28.284	9.283	20.000	.01250
81	6561	531441	9.000	4.327	28.460	9.322	20.083	.01235
82	6724	551368	9.055	4.344	28.636	9.360	20.165	.01220
83	6889	571787	9.110	4.362	28.810	9.398	20.247	.01205
84	7056	592704	9.165	4.380	28.983	9.435	20.328	.01190
85	7225	614125	9.220	4.397	29.155	9.473	20.408	.01176
86	7396	636056	9.274	4.414	29.326	9.510	20.488	.01163
87	7569	658503	9.327	4.431	29.496	9.546	20.567	.01149
88	7747	681472	9.381	4.448	29.665	9.583	20.646	.01136
89	7921	704969	9.434	4.465	29.833	9.619	20.724	.01124
90	8100	729000	9.487	4.481	30.000	9.655	20.801	.01111
91	8281	753571	9.539	4.498	30.166	9.691	20.878	.01099
92	8464	778688	9.592	4.514	30.332	9.726	20.954	.01087
93	8649	804357	9.644	4.531	30.496	9.761	21.029	.01075
94	8836	830584	9.695	4.547	30.659	9.796	21.105	.01064
95	9025	857375	9.747	4.563	30.822	9.830	21.179	.01053
96	9216	884736	9.798	4.579	30.984	9.865	21.253	.01042
97	9409	912673	9.849	4.595	31.145	9.899	21.327	.01031
98	9604	941192	9.899	4.610	31.305	9.933	21.400	.01020
99	9801	970299	9.950	4.626	31.464	9.967	21.472	.01010
100	10000	1000000	10.000	4.642	31.623	10.000	21.544	.0100